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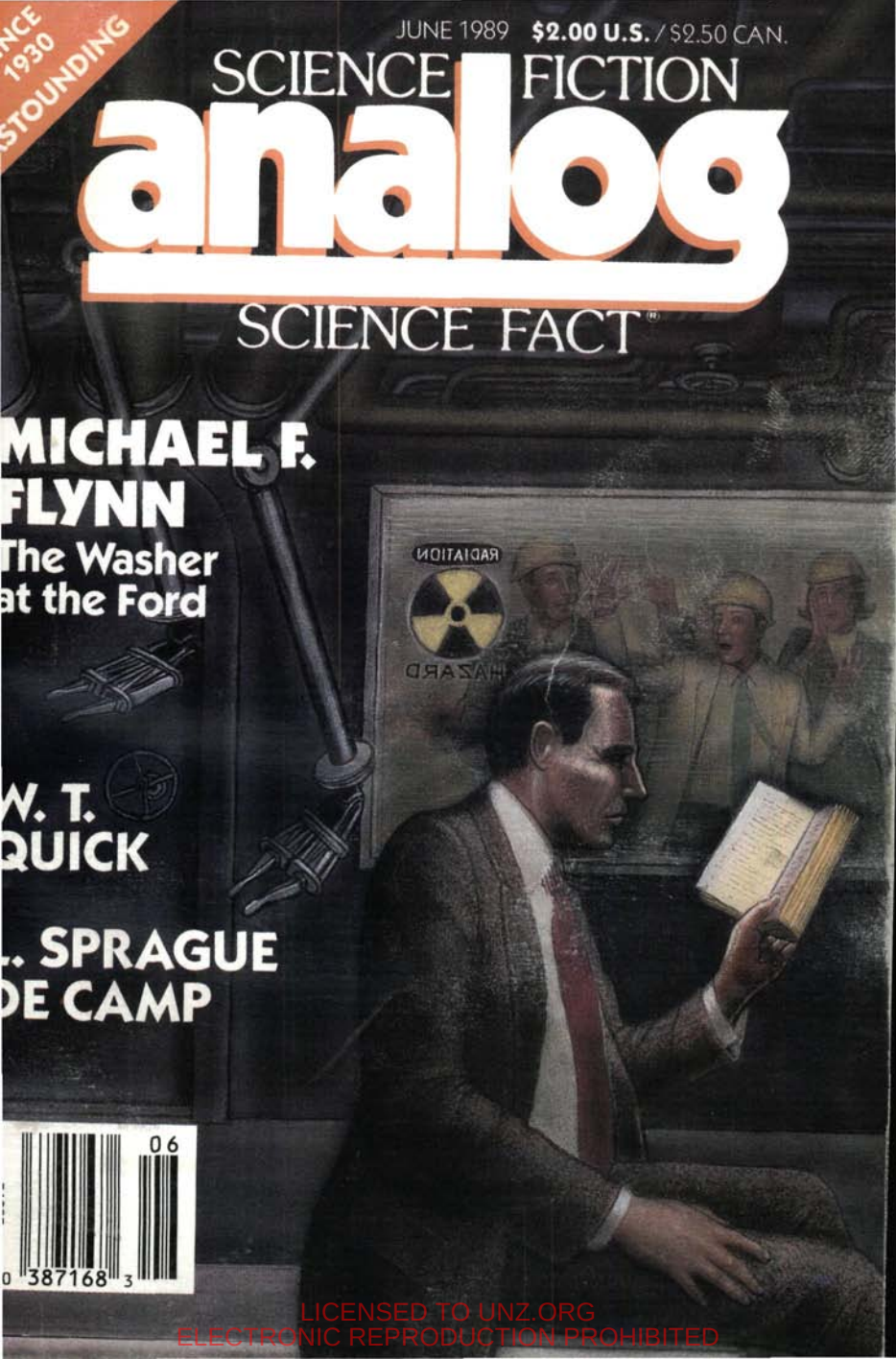

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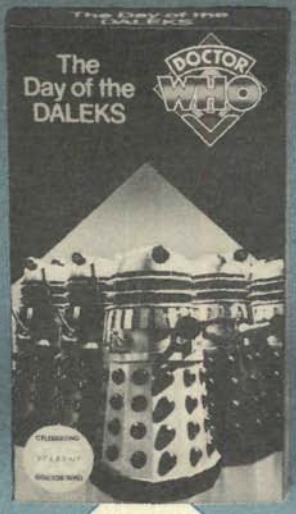

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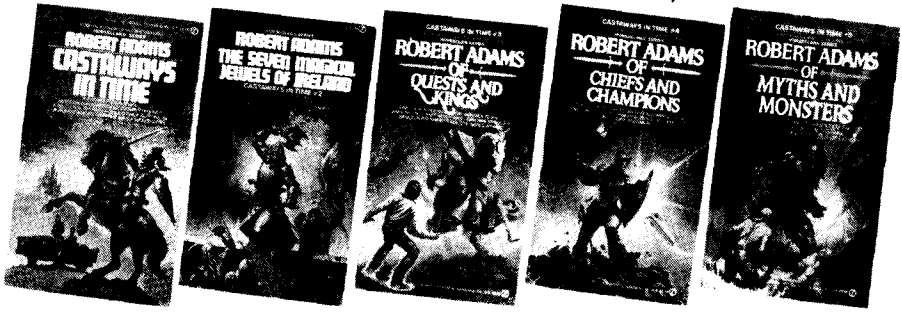

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analog

Vol. CIX No. 6
June 1989

Next Issue On Sale
May 30, 1989

$25.97 per year in U.S.A.
$2.00 per copy in U.S.A.

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Editorial

TOOLS OF THE TRADE

Stanley Schmidt

A while back, I received a critique from a reader in the form of the entire text of one of my editorials ("Pure Art and Electronics"), torn bodily from the magazine and annotated by the anonymous sender. The editorial made several references to things an author or editor—*any* author or editor—might do. To avoid interminable references to "the author" or "the editor," it sometimes used the appropriate case of the pronoun *he*, in accordance with a usage which, rightly or wrongly, has long been established as standard in English. The anonymous but obviously angry reader's annotations consisted of a circle scrawled around every impersonal "he" or "him," and the single comment, "Do you want to alienate all your readers who don't choose to be *he*'s?"

Actually, I've known very few people who *chose* to be either a "he" or a "she." But, flippancy and nitpicking aside, the answer is: of course not—and I'm grateful that many "she's" are not so easily alienated. Unfortunately, when I'm writing in English, I must use the tools English provides—or else invent new ones *and* get them immediately accepted by most of my readers so they do not distract attention from what I'm trying to say. English as it now exists does not have a separate genderless pronoun—but it does have a long history of using "he" for that purpose as well as its gender-specific one. The ambiguity is unfortunate, but if I'm going to write in English as it is generally understood, I'm stuck with it. I wish English *did* have a genderless third person pronoun, and several other genderless features such as forms of address. If it did, I would certainly use them, and be glad

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to have them added to my tool kit. But it doesn't. Since some people do feel as this reader does, it's reasonable to hope that such a change will eventually occur. But it hasn't happened yet; I can't make it happen singlehandedly; and if I try to, the effort *will* distract from the content of what I'm writing—for more people than my use of the present standard forms.

A more articulate, or at least detailed, attack on the use of those forms is found in Ursula K. Le Guin's introduction to the Women's Press edition of *The Language of the Night*. I sympathize and partially agree with her objections to the use of "he" as the impersonal pronoun, and respect her decision to change it throughout this new edition of her essays—but her basis for categorically attacking those who do not choose to make the change with her is much harder to accept or defend. She writes, " . . . the so-called 'generic pronoun' *he* . . . has been changed, following context, euphony, or whim, to *they*, *she*, *one*, *you*, *I*, or *we*. This is a political change, of course, just as the substitution of *he* for *they* as the 'correct' written form of the singular generic pronoun—see the OED—was a political act." Well, maybe it was—but nobody I know was around to participate in it. It is just plain *wrong*, and hence unjustifiable, to judge present writers' motives as if they had. "Having . . . admitted that *he* means *he*, no more, no less, I can't let it stand in these essays, because it is a mistake." No, it is *not* a mistake. It *is* ambiguous, but it is not incorrect, because this is one of its standard, accepted uses.

"*He* means *he*, no more, no less . . ." is true only if the writer is using it that way; to accuse him of that without grounds is wrong. If it were a nonstandard usage, of course, he would have to specify what he was doing; since it is a standard usage, he does not. There is a problem, but smugly accusing people of motives they do not possess seems more likely to compound the problem than to solve it. The problem is with the language—the tool kit the writer shares with his or her readers—and not necessarily with the writer's Evil Intent. The problem is one of ambiguity — uncertainty as to which of two widely accepted meanings is intended—and not with perverse use of a word in a sense contrary to any generally accepted. And the problem is hardly unique to this word. *Most* words in English have more than one meaning.

Nevertheless, ambiguity is not a particularly *desirable* thing in communication, especially on a subject loaded with strong emotional connotations for many people. So while I cannot agree with some of the specific things Ms. Le Guin says about it, I most definitely agree that *he* is not a very good tool for its secondary job. What alternatives are available? The only one I know of in the existing kit which completely avoids ambiguity and inaccuracy is "he or she." But that is long and cumbersome, and it doesn't take many repetitions for it to become tedious and annoying, attracting more attention to itself than to what the writer is *saying*. Another possibility is to alternate: refer to the first generic person mentioned as "she," the second as "he," and so on. But some

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of those references are doomed to be not just ambiguous, but inaccurate. *He* has an established and widely accepted usage for referring to an unspecified person of either sex; *she* does not. Therefore the reader may quite reasonably picture the "she" references as female-and-nothing-else, which makes them less general than they are intended to be. A similar problem arises with most of the other choices Ms. Le Guin suggests. Neither "she," "you," "I," nor "we" is generally understood to have the general meaning as well as its specific one—so the images they conjure are too specific for a truly general discussion. "One" is sufficiently general, but most English speakers consider it annoyingly "stilted" if they hear it very often. (Which, by the way, is an interesting example of how differing attitudes are built into languages. I think

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Analog Science Fiction/Science Fact (Astounding) is published 13 times annually by Davis Publications, Inc. at $2.00 a copy in U.S.A., $2.50 in Canada. Annual subscription $25.97 in the U.S.A. and possessions, in all other countries, $30.67 payable in advance in U.S. funds. First copy of new subscription will be mailed within eight weeks of receipt of order. When reporting change of address allow 6 to 8 weeks and give new address as well as the old address as it appears on the last label. Second-class postage paid at New York, NY, and at additional mailing office. Canadian 3rd class postage paid at Windsor, Ontario.

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IN CANADA RETURN TO 1801 SOUTH CAMERON, WINDSOR, ONT. CANADA N9B 3E1
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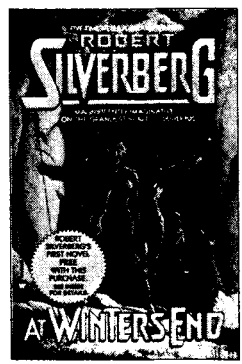

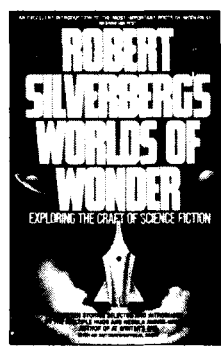

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most English speakers have that reaction to "one," and therefore don't use it much; but its German counterpart is quite generally used and, as far as I know, has no such stigma attached to it.) "They," together with corresponding use of plural rather than singular nouns, may be suitably general—but it is *plural,* and *only* plural. Thus it isn't really very appropriate, for example, if you're talking about how a reader reacts to a story. Reader reactions are very individual things, and not at all the same for all readers. Saying "readers react . . ." is likely to convey the incorrect impression that they all react the same way.

Despite the semantic shortcomings of these standard English substitutes for the impersonal *he*, we've all been subjected in recent times to a great deal of pressure to use them instead. Fairly often, one of them actually works without undue mayhem to the meaning, and many if not most writers have been developing the habit of trying to use alternatives when they can. If you look closely, you'll find several examples right here in these paragraphs (including this sentence). But those book publishing houses that have set forth as Official Policy that they will Stamp Out Sexism by insisting that writers *always* use alternatives go too far. There are times when clarity and accuracy call for a pronoun that is simultaneously general, singular, and genderless—and, unsatisfactory as it is because of its other meaning, the "generic *he*" is the best that English As She Is Spoke has to offer.

Which leaves us the option of inventing a *new* tool: a pronoun that is simultaneously general, singular, genderless, and *never used as anything else.* In principle, I can do this at the beginning of any piece of writing, use it as such throughout, and expect readers to understand it as I've defined it. In practice, there's a major difficulty with that: words, unlike other tools, cannot be adopted unilaterally by a single user. A word is a tool which, to be used at all, must be shared by at least two users: a writer or speaker and a reader or listener. Both must agree on what it means, and both must accept it as an appropriate tool for the job. The latter condition is, regrettably, not met for all people by the impersonal *he*. But my experience indicates that an invented word will almost always fail to meet it for even more people—and the little words, like pronouns and prepositions, are the hardest of all to get people to accept. They are part of the structural framework of the language, while nouns and verbs are more like movable and replaceable attachments. New nouns, verbs, and adjectives, like "quark," "grok," and "groovy," enter the language fairly often and without much difficulty. But when was the last time you saw a new pronoun or conjunction catch on? I don't recall *ever* seeing it happen in my lifetime.

I *have* tried the experiment in fiction, though. I once wrote a story involving a species of aliens with three sexes. Since the culturally defined roles of those sexes permeated their society as thoroughly as do those of our two sexes, I originally thought that the only accurate and intellectually honest way to tell

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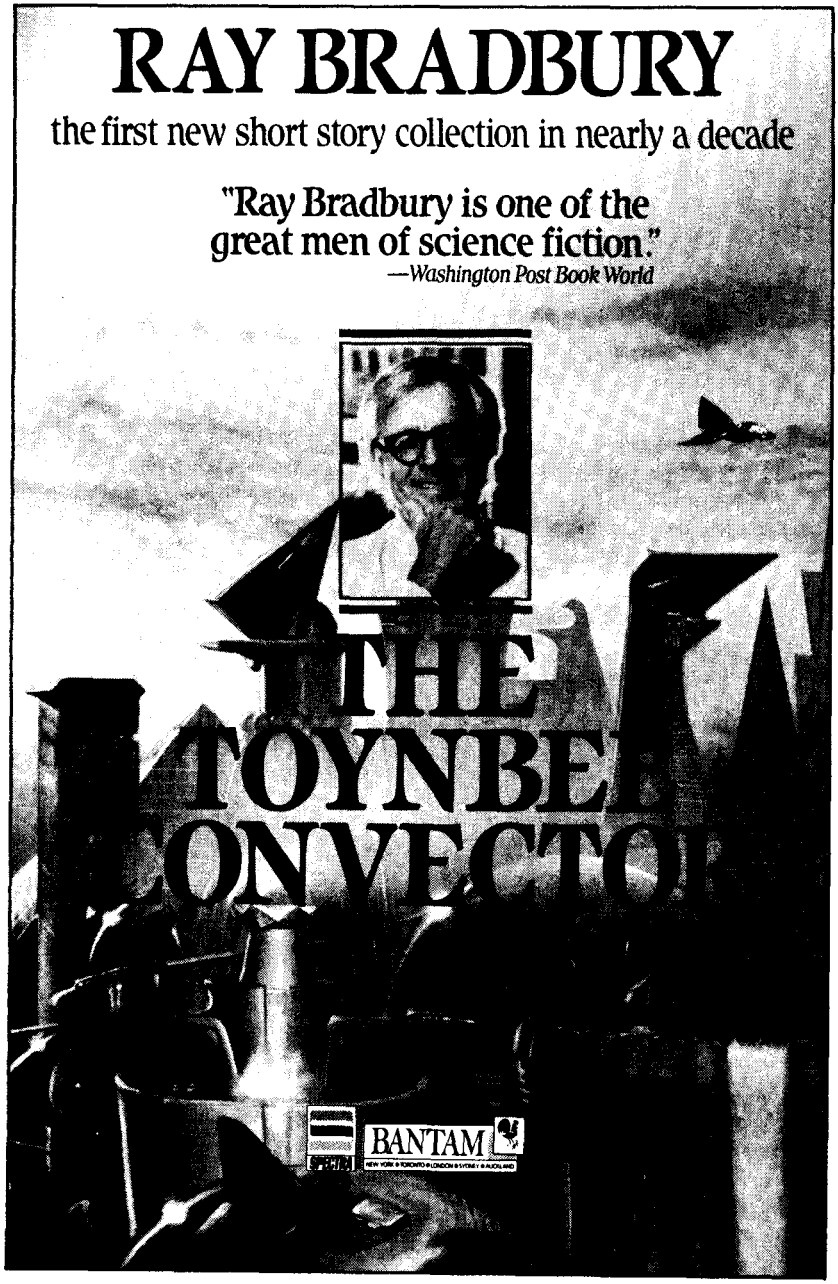

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the story, if I was going to use gender at all, was to use *three* genders with separate pronouns for each. But when I told the story that way, most people who read it found the extra pronoun so off-putting that they couldn't get into the story and enjoy it. When I recast it, forcing one English pronoun to do double duty for two of the alien sexes, they could—even though that way of doing it was less true to the actual nature of the alien society. I would *like* to have my pronouns as accurate as possible—but if the effort to do so keeps people from reading the story at all, it defeats its own purpose. I've learned my lesson. Much as I would like to see English have a genderless pronoun, the crusade to give it one is not so overwhelmingly important to me that I'm willing to let it obstruct what I'm saying about all other subjects.

Even if we do eventually get such a pronoun generally accepted, will it have the effect that its most vocal proponents want? Note carefully: accuracy alone is *not* what most of them care about. The gist of the most vehement arguments against *he* is often that use of a masculine pronoun to do the job of a genderless one tends to conceal the fact of feminine participation and therefore to contribute to the oppression of women. If this is true, avoiding that usage of *he* and substituting either a genderless pronoun or the circumlocutions already available should reduce or eliminate that tendency, and thereby contribute to fairer and more equal treatment of women. The first assumption is both disturbing and painfully plausible-looking; the second is a lovely and tempting hypothesis. But to what extent is either *true?*

The idea that the structure of a language tends to condition the ways in which its speakers think—whether they view women as superior, equal, or inferior to men, for example—has been around for a long time. It's commonly known as the Sapir-Whorf hypothesis, after two American linguists who wrote about it in the early 20th century, but the basic idea goes back at least as far as Johann Gottfried von Herder and Wilhelm von Humboldt in the 18th and 19th. It remains a topic of perennially heated debate among linguists and anthropologists. The evidence for it to date is simply not strong enough or rigorous enough to make it much more than an appealing hypothesis that sounds intuitively as if it *ought* to contain at least some truth.

In the specific instance at hand, it's not hard to find some living examples which *might* support the hypothesis—but apparently don't. Contrary to the apparent belief of many who have complained about the "generic *he*" and yearned for truly genderless pronouns and forms of address, the idea is *not* a radically new and original invention. There are many languages already widely spoken which use gender-free constructions as a matter of course, and in which you might have to make a special effort to specify gender if you wanted to. These include, to name just a few, Japanese, Swahili, and Turkish. In Swahili, *alimwona* can mean "*he or she saw him or her.*" In Japanese, *san* is a respectful suffix that can mean "Mr.," "Miss," "Mrs.," or "Ms." But such social

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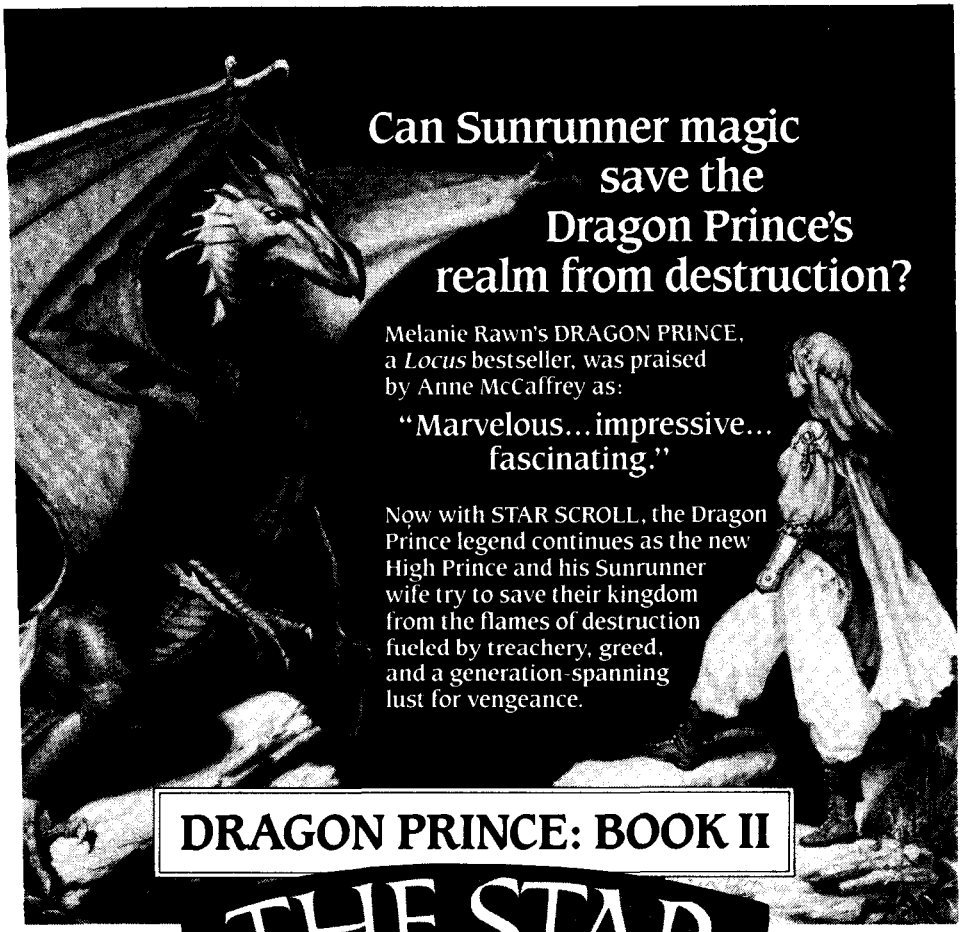
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equality as Japanese women now enjoy in practice is not a consequence of the language's ancient lack of emphasis on gender, but of sweeping reforms made after World War II. I suggest that you look into some of those other cultures for yourself, and draw your own conclusions about how effectively equal treatment in language guarantees equal treatment in society.

So—it would be nice if English had a genderless pronoun to use instead of *he* when referring to a person who could be of either sex, and something better than "Gentlemen" or "Dear Sir or Madam" to use when writing to a stranger. The existence of many languages which have such features clearly proves that they are possible. One of Ursula Le Guin's essays is titled, "Is Gender Necessary?"; the answer, at least for language, is, "Very seldom." I think it would be a fine thing if our language, like many others, recognized this. But even if it did, I doubt that it would be the cure-all that some would like. Existing languages prove that language can function, and function well, with little or no reference to gender. But the cultures that use those languages provide little support for the belief that standard use of a gender-filled language makes every user a sexist pig, or that getting gender discrimination out of language will do much to get it out of society. That is worth doing, but word games will be, at best, a minor part of the process.

To keep the peace while we're waiting for our very own set of gender-free linguistic tools, all writers might be well advised to bear in mind that the generic *he* bothers some people, and try to use existing substitutes when it can be done without undue distortion of meaning. And some women might be a bit less quick to take offense and impute sinister motives to writers who are doing the best they can with a language they did not invent. They may not like it any more than you do—but each must use the tools *it provides* that best suit his or her needs. ■

●When in doubt, take all the time you need to get all the facts.

Donald Laird

●Or all the time you *have,* whichever is less.

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THE WASHER AT THE FORD

Michael F. Flynn

There are things that most people would agree *should* be done if they can. Getting them to agree on *how* they should be done is much harder . . .

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I

Charles Randolph Singer looked at the door with its bright magenta-and-yellow trefoil warning and licked his lips. The door was gunmetal grey; the handle, one of those bank-vault kinds of handles that had to be spun like a wheel. Through the thick lead-quartz window beside the door he could see the rows of waldos used for handling the fuel rods. The guide had just demonstrated how they operated, showing a dexterity in manipulating the gloves that most people did not show with their own hands.

And I'm putting this off, he thought.

"Dr. Singer? We're going to see the waste storage pool now."

He glanced at the tour group where they waited on the mezzanine, at the doorway back to the control room. Half of them were already through it. Biologists and medical/health practitioners in suits and ties. The yellow visitors' hard hats sat awkwardly atop them. The nuclear engineer in the long, white lab coat seemed like an alien being.

He waved a hand at them. "You go ahead. I just want to see something here." To demonstrate his intention, he leaned against the quartz window and cupped his hands around his eyes to block out reflections.

The engineer herded the other biologists out. "You can't stay here without an escort," he said.

"Oh, very well." Singer turned to follow the others out of the room; the engineer stepped through the door-lock ahead of him; and he was alone for just a fraction of a second.

And that was all he needed.

A quick turn of the handle and the heavy door unlatched. Immediately klaxons sounded and an insistent red light began flashing above the hatchway. A pleasant, female contralto spoke through the loudspeakers: "The pile door is unlatched. The pile door is unlatched."

The engineer-guide stuck an astonished face through the doorlock, saw what Singer was doing, and sprinted down the stairs from the mezzanine. "Hey!" he shouted. "The plenum's been cracked for fuel replacement! You can't go in there without a suit!"

The heavy, dull-white radiation suits hung on rows of hooks. Their shapeless hoods, with the single, rectangular visor set like Cyclops' eye in the center, gave them a weird, unearthly appearance. Singer ignored them and stepped through the open door.

He pulled it shut just as the engineer reached it. It slammed with a satisfying chunk, and he spun the inside wheel. That wouldn't keep them out for long; but he only needed a moment.

With movements long rehearsed in his mind, he turned to the inner door of the air lock and punched in the five digit number that was supposed to unlock it. There was a pause, and Singer wondered if the number he had been given was correct. Then the door clicked and hissed.

Once the inner door was unlatched, the outer door could not be opened. Singer leaned his right arm against the doorframe, and rested his forehead on it. He let out a slow breath. He had made it.

He straightened up and stepped into the containment structure. A maze of plumbing filled most of the interior. Steam pipes. Condensate pipes. Coolant

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pipes. All of them were color coded and marked with arrows showing the direction of the flow. The codes and symbols were runes, without meaning, save to the engineers that interpreted them. Singer was able to identify the coolant pump only because it was making pump noises. He knew that the other large structures were the steam generators and the pressurizer, but he didn't know enough about engineering to tell them apart. It was all very mysterious—like an immense abstract sculpture. A mix of symmetry and chaos. "Touch nothing, no matter how bored you get." Good advice, thought Singer. Though, considering where he was, caution seemed a little silly. Like wearing galoshes during a hurricane.

He walked to the reactor and inspected it curiously. The pile itself was contained inside a larger plenum assembly, now open, which also contained the control rods, guide tubes and other auxiliary equipment. Singer gazed for a moment at the exposed "guts." Murchadha had told him it was a CANDU, whatever that meant.

He stood by the edge of the pile. He could feel the heat from it, feel the neutrons piercing his skin. Or was that his imagination? Who knew? Who had ever lived to describe it? He closed his eyes and imagined himself on the beach, sunbathing; the solar radiation turning him a nice golden tan. He stretched and turned slowly. It was like sunbathing. A smaller sun perhaps, but much closer.

When he looked over his shoulder, he saw his erstwhile companions pressing their faces against the quartz glass window, like children at a candy store. Or at a zoo. That was a more apt comparison, he decided. A zoo. Peering at a very strange critter indeed. The faces he saw there were a mixed lot: distraught, curious, and even—in one instance—eager! *Ghoul,* thought Singer. The engineer was talking animatedly on a red telephone.

Singer waved at his audience. He found an exposed I-beam in full view of the window and monitoring cameras and sat down on it. It was important that they realize he was not a terrorist, that he was no threat to the reactor. So, after his first curious inspection, he paid no further attention to the pile or other generating equipment. Instead, he pulled a paperback book from his jacket pocket and opened it. Classic Heinlein. *The Man Who Sold the Moon.* He began to read.

I should have brought *The Green Hills of Earth,* he thought. Rhysling's story was more *apropos* his current situation. Especially that last part, in the ship's reactor room.

As the word spread through the power plant, more and more people crowded up against the viewing window. Singer ignored them and concentrated on his book. Once or twice, he glanced at the window for a casual head count. Then he would lick his thumb and turn a page in the book. He tried to ignore the voices in his head.

"You don't take failure very well, do you, Charlie?" said one voice.

"The problem with edges," said another. *is that it's too easy to topple off them."*

And a third: *"Then, you do not believe it is possible?"*

And *"Please, don't talk yourself into doing something I can't live with."*

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Resolutely he stared at the pages, gripping the ancient, tattered paperback.

"There are no final solutions, Charlie."

"Maybe not," he muttered aloud. Then he realized that the people crowded at the view port could probably hear him over the intercom. Talking to himself. He flushed. They must think I'm nuts. Then he remembered where he was and laughed.

"Maybe not," he said again, as much to himself as to the voice. "But at least there are temporary ones."

He remembered the emptiness of the Lab when he last visited it, just before coming here. Everyone gone, scattered. His footsteps had echoed in silent rooms. The terminal screens were dark; the equipment, shut down, mute and accusing. And who knew when, or even whether, they would be powered up again?

How did it come to this? he asked himself. But it was a rhetorical question, because he knew very well how it had. He could remember every step along the road. Every stumble. He could remember the insistent ringing at his door that had started the whole thing.

II

When Singer answered the doorbell on the first floor of the laboratory building and saw Masao Koyanagi standing outside, he did not know who it was.

His door opened only an inch, held in place by a diamond-fibre chain that he had knitted himself. It was built up from intricately bonded layers of carbon atoms grown in a vat. No in-mugger's bolt cutter could break it. He peered through the crack and saw a short, thin Japanese man, wearing a bluish grey suit with the faintly iridescent, diagonal pinstripes that were the fashion rage among businessmen that year. The man's hair was impeccably groomed; his nails, buffed to a sheen.

"Yes?" said Singer suspiciously. It might be a *zaibatsu* sales rep. The Niprazilians were constantly pestering him for permission to produce or market his inventions. Singer preferred his own privately held company and subcontracted whatever manufacturing work was necessary to local concerns. He was small and, God willing, he would remain small. Giant corporations had been the death of American business, and were already strangling Japanese and Brazilian enterprise with their bureaucratic inertia.

"Dr. Singer?" the stranger asked. "Have I the honor of addressing Dr. Charles Randolph Singer?"

"You're doing it," Singer allowed. "Whether it's an honor or not is up to you."

The stranger chuckled nervously and glanced behind him. "May I come in for a moment?" he asked.

Singer closed the door, unlatched the diamond chain, and opened the door again. The stranger scurried through and Singer banged the door and shot the bolt.

"You're taking a big chance, going out alone," he said. "Not only outmuggers. There's plenty of folks around the Northeast who like to play 'Trap the Jap,' Mister—?" He let the word drawl out.

"Ah. I am Koyanagi-sama Masao, ah, that is Dr. Masao Koyanagi." He

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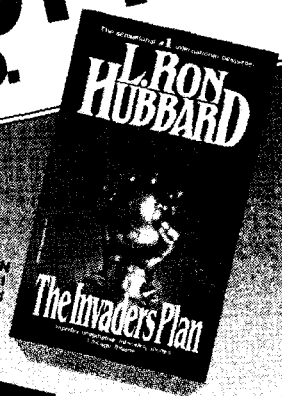
IT WON'T LET YOU GO.



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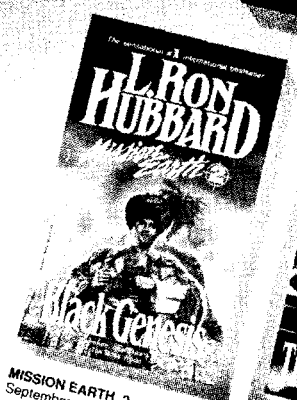

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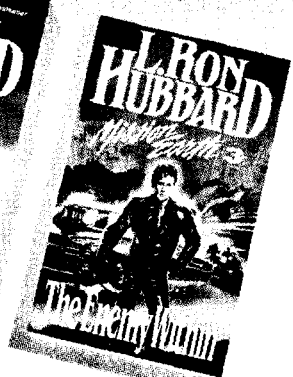

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bowed partway, equal-to-equal, and a business card appeared, as if by magic, in his cupped, outstretched hands.

Singer sighed inwardly. *Meishi*. He took the card, using only his right hand, though, strictly speaking, he should have used both hands. The Japanese made a big deal out of presenting their business cards; and a powerful lot of Americans, he knew, were taking up Japanese customs and behaviors, all the *giri* and *gimu* nonsense. But, Singer didn't hold with that and delighted in displaying so-called "American crudeness." After all, Koyanagi was wearing Western clothing, not a kimono. And a lot of the Japanese in Brazil were picking up Brazilian manners, or at least, so he had heard. Crudeness was all a matter of culture and taste.

However, he was not so crude as to take the card with his left hand.

"All right, Dr. Koyanagi. What do you want?"

"I would like to do business with you," his visitor replied bluntly.

Singer sighed. "I thought so. Another sales rep. Which *zaibatsu* are you from? No, never mind; I don't want to know." He walked to the door. "Don't let the doorknob ream your ass on the way out."

Koyanagi grimaced. "Please, Dr. Singer-sama. It is not that at all. I am a scientist; I represent only myse—"

"A scientist. Wait a minute!" He pointed a finger at him. "You're not the M. Koyanagi of São Paulo Biophysics Laboratory, are you? The *Further Study of* M. radiodurans *under Robust Levels of Gamma Radiation*? That Koyanagi?"

The visitor bowed again, much lower this time, showing gratitude. "I am honored that you would know of my unworthy efforts."

Singer reached out and tapped the man on the chest with his forefinger. "You owe me a half-million novocruzeiros! The nanomachines you used to enhance that bacterium were proteins that I patented."

Koyanagi winced. "Please, Dr. Singer. That is an issue you must address to São Paulo. If it were only myself, I would pay you the NCr 500,000 and more, and welcome to it. Without your nanomachines my work would have been impossible."

Singer paused. "Then what—"

"I bring you an opportunity to become rich and famous."

"I'm already rich and famous," Singer grunted, "but now you've got my attention. Come on upstairs and set a spell."

Singer had converted the second floor of the building into a comfortable apartment. It was equipped with kitchen, living room, two bedrooms, a library, some rooms that varied in their functions. The living room ran the full width of the building and had a picture window at each end. In square footage the apartment was as big as most houses. Singer also had a home in the country, but normally spent only his weekends there. He liked to stay close to the action.

He let Koyanagi into the apartment and looked around. "My wife's out right now," he said. "Go on. Have a seat, son, and keep talking about making me rich." He gestured to the couch in the apartment's living room. "Can I offer you anything? Tea?"

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Koyanagi smiled. "No, but a shot of *cachaça* would be fine."

Singer jerked his head around. He grinned. "Acculturating, are you? Let me see what I have." After a few moments he returned with a glass of dark liquid. "Couldn't find any *cachaça*, will Barbados rum do?"

"Very nicely, thank you." Koyanagi took it and tossed it off in one swallow. "At the train station," he said, "I felt as if all eyes were on me. Not friendly eyes, either."

Singer shrugged. "What do you expect? They have to blame somebody for the economic mess they're in, so it might as well be you. Brazilians have the same problem, except most of them pretend to be Puerto Ricans to make themselves socially acceptable. Did you walk here from Metropark Station?"

"No cab would take me."

"Hmmm, no. Not without a Nisei badge, and maybe not even then." He took a seat facing his visitor. "So, tell me, Dr. Koyanagi, why are you here? This is no casual visit, obviously. How do you plan to make me rich?"

Koyanagi drew himself up and launched himself into what seemed a prepared speech. "Dr. Singer, you are the world's foremost authority on nanotechnology. You hold more biogenetic patents than any living individual. People have compared you to—"

"Thomas Edison. Yes, yes, I know. That's why I built my laboratory here in Menlo Park. You see that tower outside the north window? That was where Edison built his original 'invention factory.' But, son, you did not come 8,000 miles just to tell me I'm a great man. I already knew that."

"So. I am buttering you up. Is that the phrase? Most peculiar. The Persians say 'I am putting melons under your arms.' No. I have a request to make of you." He hung his head and rotated the empty highball glass between his two hands. "I have made a most intensive study of *Micrococcus radiodurans*," he said, after a moment of silence. "You know of it?"

Singer nodded. "It's a microorganism with a high resistance to radiation. It can survive radiation levels that are, what? A thousand times the lethal dose for humans, right? A million years' worth of normal background radiation delivered in one punch."

Koyanagi nodded vigorously. "Yes. Yes. Kitayama and Matsuyama studied it extensively in 1979. I have expanded on their original work. I believe the organism's resistance is due to internal protein structures, rather than to its simplicity, as everyone has assumed—"

Singer nodded. "All right," he interrupted. "You're a certified genius and a pioneer. Go on. How does *M. radiodurans* make me any richer than I am now?" Singer leaned forward eagerly. There was a cash flow problem developing in the lab and new ideas for income were always welcome.

"Hmm. Does the *senhor* recall the *Mir* disaster?"

Singer blinked at the change of subject and sat up straight. "The Soviet space station? Yes, of course. The solar flare caught them unprepared. There were three cosmonauts up there and two of them died almost immediately. It set their space program back by half a decade."

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"The third man also died, from delayed cancer, a few years later."

"Yes, I remember. What of it?"

"I was wondering." Koyanagi looked up, then out the window where the Edison tower stood. "What if those cosmonauts had been . . . well . . . 'inoculated' with *M. radiodurans*?"

"Inoculated?" Singer felt a tingle move through his body and leaned forward again. "What are you trying to say?"

Koyanagi looked at him. "Proteins are strings of lumpy beads. If they fold up the right way, the lumps can fit together like the pieces of a Chinese puzzle, and form enzymes and hormones. There are . . .'sticky'? Yes, 'sticky' places on molecules. Could the proteins that *M. radiodurans* uses be folded in such a way that they could stick to, say, the white blood cells, so that—"

Singer straightened. "So that humans would become radiation resistant, too?" he finished. "So the proteins could repair human cells, instead? Son, that is the craziest, most off-the-wall notion I've ever heard!"

Koyanagi's face fell. "Then you do not believe it is possible."

Singer laughed. "Hell, I said it was crazy. I didn't say it wouldn't work. Crazy ideas are the only ones worth trying." Singer stuck out his paw and engulfed Koyanagi's manicured hand. He shook it vigorously. "Welcome to Singer and Associates, Dr. Koyanagi!"

SingerLab's conference room was centered on a round wooden table, inlaid with touchpads and sunken terminal screens. A portable lectern with a Mystica pad stood in the front of the room, and the entire front wall was taken up by a flatscreen electronically connected to the pad. Singer and the other Associates sat in padded swivel chairs, listening while Koyanagi outlined his concept. Singer wanted everyone to have the same, clear vision of the goal; and where better to get it than from the original visionary?

"If only small areas of the body are affected," Koyanagi was saying, "human beings can tolerate remarkable levels of radiation. Even though the affected tissues die, the organism survives. That, in fact, is the basis for radiation therapy for cancer. However, even small doses can be fatal if delivered as whole-body irradiation. Tolerance varies from person to person, but generally speaking, dosages in the 600 to 800 rad range are 100 percent fatal; while doses running 400 to 600 rads are 50 percent fatal. To put these numbers in perspective, recall that the levels reported 20 km downwind of Chernobyl fell in the range of 450 rads."

Singer listened carefully, taking notes on his terminal. Masao wasn't telling them anything new, of course. That wasn't the purpose of the initial briefing. The idea was to tune everyone's thoughts to the same channel.

"Our task," Koyanagi continued, "is to raise the radiation level that human beings can tolerate. The old term for this was 'hardening.' We have long known of ways in which people can be hardened to some extent. For example, a diet rich in green vegetables coupled with large doses of Vitamins A and E can affect a 30 percent reduction in the damage done by radiation. What I envision, however, is a prophylactic, taken

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in the form of a pill, perhaps, or an injection, that will 'install' in the human metabolism the same sort of molecular machinery that some lower life forms possess."

"A vaccine against radiation," mused Jessica Burton-Peeler. She was a mature woman with a Rubenesque figure; the kind that men once found attractive, in the days before anorexia became fashionable. She wore owlish glasses and a dark blue suit with a ruffled blouse. She was the second-best geneticist in North America.

"Correct, Doctor Peeler," replied Koyanagi. "A vaccine. But how is it to work? Radiation consists of fragments of shattered atoms: broken shards of nuclei, individual particles, high energy photons. These act like subatomic 'bullets.' When they strike atoms within the tissues of the body, they knock electrons loose, ionizing the cell material, and causing abnormal chemical reactions. Since living tissues depend upon precise and elaborate sequences of chemical reactions to perform their functions, these abnormalities can easily prove fatal. The cells reproduce themselves too slowly—they are destroyed faster than they can be replaced—or else the replacement cells themselves are abnormal. The problem, therefore, is one of broken molecules. What I envision is quite simple. A nanomachine that will paste these broken molecules back together as fast as ionizing events can fracture them."

There was a moment of silence before Kalpit Patel blurted, "Then I am glad that what you envision is not complex!" The microbiologist was a second generation Indian-American. His skin was coffee-colored and he sported a caterpillar moustache and thinning, gray hair. At fifty-two, he was the oldest of the group.

Koyanagi smiled. "Yes. The goal—to harden humans and the objective—a cell repair nanomachine—are easy to state. Perhaps not so easy to do. However, I am sure that this illustrious group can do so, if anyone can."

Singer thanked Koyanagi for his briefing. Koyanagi bowed and took his seat, and Singer strode to the front of the room, where he activated the Mystica pad. He looked over the group and grinned, tossing the electronic stylus in the air and catching it.

"I can see by your faces that you think Masao has dreamed up a pretty harebrained scheme. I agree. Let's go for it." There was a round of laughter and Singer added in his mountain drawl. "Aw shucks, folks, if'n it were easy someone would a-done it already. Besides," he added more sternly, "easy jobs bring small rewards. The potential profit here is enormous. The market includes not only cosmonauts and nuclear plant workers, but people living *near* nuclear plants, afraid of a meltdown. And Radiologists. X-ray technicians. Miners. Anyone who works around radioactives. I estimate near total market penetration within five years of product launch; and the market itself will expand as *Bandeirantes Interplanetarias* adds to its L4 manufacturing complex."

He paused and let his eyes sweep the group, pausing on and challenging Jessie's thoughtful gaze. "Make no mistake. The investment will be substantial. Our operating margin will be paper thin. So, we need to push through all our

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pending income-producing projects, especially the monomolecular telecomm cable and the aerosol room freshener. But on the other hand, the return can be equally substantial, *if we can make it work*. I think we can.

"The good news is: I don't expect competition. Only Dr. Koyanagi here has evidence that *M. rad*'s resistance is due to special proteins, and not to structural simplicity. Now, that may or may not be true, but the data he showed me looks very good. If we can humanize that protein into a compatible enzyme or hormone, we can pretty much write our own ticket. People will line up outside the door there with cash in their hands. The question is: Can we make it work at a reasonable ROI? What are the issues that want to be solved?"

"Configuration, for one," said Patel. "What is the design envelope to be relative to cell size? How fast should it act? What are the limits of radiation flux against which we should design?"

Singer nodded without speaking. He began writing on the Mystica pad and a larger than life version sprang into existence on the flatscreen set in the back wall. He wrote "Rad Repair Nanny" on the right-hand side and drew an arrow pointing to it. A 45° branch off the main arrow he labelled "Configuration" and added three stems corresponding to the three points Patel had raised. He did not address any of the points, nor did he allow anyone else to discuss them.

"What else?" he asked.

"We must identify the protein," offered Koyanagi.

"And tailor it to fit human molecules," added Patel. He looked at Koyanagi, who nodded.

"Concept," said Eamonn Murchadha. He was the youngest of the group. A redhead with freckles, he seemed hardly more than a college student. Yet, he had already made a name for himself as a nanomachinist. "There are at least a half dozen ways of designing the little darling. We need to decide on the best approach before we can talk about specifications. We could flood the bloodstream with millions of nannies, so they would circulate throughout the body looking for damaged cells—"

"Yes," interjected Koyanagi. "They could be designed as a variety of leukocyte."

Patel gazed thoughtfully at the ceiling. "Or we could," he said, "hardwire it into the chromosomes."

"And access," said Murchadha. "The nanny must be able to get inside the cells."

"Only for free-swimming designs; access isn't an issue if it's an on-site nanny."

"No, regardless. If you're going to install it in the cell, you still have to get the 'construction company' inside the membrane."

Koyanagi agreed. "I used a modified T4 phage in my work."

Patel rubbed his moustache. "T4, eh? Inject the instructions into the cell and let the nanny build itself on-site?"

"What about incision-and-sew? That's faster," Murchadha commented.

"Jessie," said Singer. "You're being unusually quiet today. "Do you have any thoughts on this?" He knew she did. She had opinions on everything.

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Sometimes several. She had been staring pensively at the idea tree, her lips working like they always did when she was deep in thought.

"Very well," she said slowly. "This is a more difficult task than I think you appreciate. If the cash flow is going to be as tight as you say, perhaps we should not get into this at all."

Koyanagi looked shocked, but Singer wrote the comment down anyway. Jessie had a point. A negative point, but still a point. If the nanny couldn't be built for a profit, there was no purpose to it. Only he wished that she wouldn't go out of her way to phrase things negatively.

"Furthermore," she continued, "It won't do any good to repair the enzymes and hormones if the RNA has been damaged."

"That's right," added Patel. "And fixing the RNA won't help if the DNA has been hit."

"Then write these down, dear," said Burton-Peeler, a bit smugly. "We must address three levels of repair: First: corrective action on the proteins. Second: repair of the RNA. Third: correction of the DNA."

"What about the 'raw material'?" asked Murchadha. "Defective amino acids?"

"Unnecessary," she told him. "If the RNA is right, it will reject any defective components."

"No critique yet," Singer reminded them as he recorded Murchadha's comment. Cells were like little factories, he thought. They took in amino acids and converted them into proteins in mitochondrian "workshops." The RNA were the "stamping dies" delivered from the nuclear "design department" where the DNA "blueprints" were kept. Glandular chemical plants. Neural telecommunications. Food and transport. The body was a complete economic system in miniature.

He realized he was letting his mind wander. "I'm sorry, Kalpit. What did you say?"

"If the nanny is to work on the DNA, it must cross the nuclear membrane, as well," said Patel. "I think we will use your $T4_2$," he told Koyanagi.

"No decisions yet," warned Singer.

"Recognition," said Eamonn Murchadha. "It would be a shame if the nanny didn't know a damaged cell from a healthy one. What if it starts to 'repair' a healthy cell?"

"Then it needs to be able to detect ionization."

"Ionization that doesn't belong. Remember, there's ionized calcium in the intercellular space."

Koyanagi pointed to the diagram growing on the wall. "Please. Would you place a DNA library on the recognition branch, Doctor Singer?"

"And don't forget standards. The nanny will have to create its own standards for the DNA library," Patel pointed out. "That goes on the recognition branch, too."

"Then the nanny must enter the cell nucleus and inspect the DNA tapes," said Burton-Peeler. "And be able to tell if those tapes are damaged or not. There are millions of codons on a single strand, you know. That's an awfully large information load."

"We'll need a processor to control the whole thing. How about Tiny NIM?"

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"Does NIM have the capacity for this job?"

"What does the 'nanny' do once it identifies a damaged cell?" asked Koyanagi. "It must be able to tear down the old structures and replace them."

"That's right. Create another major branch, would you?" said Murchadha. "For assembly and disassembly. The nanny needs restriction enzymes to cut and paste the strands. I think we can use commercial grade mutS and mutH and maybe build on a DNA polymerase."

"Prioritization," said Patel. "The nanny must know to concentrate on the most critical tissues. Nervous system first."

"Why nervous system?" asked Burton-Peeler. "Aren't the lymph tissue more sensitive?"

"Yes," said Koyanagi, "but the body doesn't replace nerve cells. Death from radiation sickness is almost always a nervous system disorder." He faced forward again. "We should also address the bone marrow. Since blood cells turn over more rapidly than other cells, symptoms generally appear there first."

The brainstorming continued for another two hours, until everyone was exhausted and wrung dry of ideas. Singer stood like a Socrates, controlling the discussion without appearing to. If the talk turned to critique, he squelched it immediately. The important thing was to keep the ideas flowing freely. If a participant became reticent, he drew him or her out. If the discussion wandered off the topic, he tapped the arrowhead of the diagram with his wand and brought them back.

Afterward, they cleaned up the diagram, moving ideas from one branch to another, adding details, clarifying comments. Then they prioritized the list in order of importance. First Priority was to identify the relevant protein structures of *M. radiodurans*. That job went to Koyanagi and Burton-Peeler. Meanwhile, Patel and Murchadha would simulate alternate design scenarios. Once the relevant design decisions were made, Burton-Peeler would tackle the access and recognition systems; Patel and Koyanagi would collaborate on designing a protein that would simulate the benefits of *M. radiodurans*, but which would fold up in such a way that it would stick to normal bloodstream molecules; and Murchadha would prepare the restrictor enzymes and other features of the nanny itself.

Singer promised to document all the tasks on a PERT chart and awarded himself the job of specification and configuration control. All the parts of the project had to fit together properly, just as they did in machinery. Design decisions must harmonize. Otherwise, the solution to one problem could end up blocking the solutions to others.

After the meeting broke up, Koyanagi lingered, studying the idea tree that they had generated. Singer sat at the table watching him. There was something on Masao's mind. He could tell from the man's self-conscious absorption. "So. What do you think of my little crew?" he asked.

Koyanagi turned. "What? Oh. They are very able. If any team can solve this problem, it is yours. But I do not think they would solve it if not for you."

"Oh?" Singer pulled out a stick of

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sugarless gum and popped it in his mouth. "Are you putting them down? We've been together for a coon's age, you know. Longer'n that for me and Jessie."

"Putting them down?" Koyanagi frowned over the idiom. "Oh, you mean am I disparaging them? No, by no means, *senhor* Singer-sama! It is just that you are the . . ." He waved a hand in the air, searching for a word. "The motivator. The driving force. You define what problems are to be solved."

"Hünh." Singer was not impressed by praise. A fact was a fact. Patel or Murchadha would be brilliant researchers in any setting; but under his tutelage they were brilliant creators, as well. Picking the right problem was at least as important as solving it. Edison had been that way, mostly, and Singer knew he had the talent, too. That rare ability to separate the vital few ideas from the trivial many. No brag, like Walter Brennan used to say on that old TV show. What was its title? Singer had forgotten. No brag—just fact. Even Jessie admitted it.

And Jessie never admitted much. She didn't like being the "second best" geneticist.

"What is Tiny NIM?" asked Koyanagi. His finger traced the twig on the idea tree. "I wanted to ask during the discussion, but I did not want to interrupt the flow of ideas."

"Tiny NIM is our nanocomputer. It stands for Nanoscale Integrating Machine. It's only a prototype right now, limited to specific tasks; but someday we hope to expand it into a general purpose computer. It's mechanical, actually. All gears and wheels and cogs. But it's faster than electronics because its parts are the size of molecules."

Koyanagi frowned. "Is that possible? That a mechanical computer can be faster. After all, electronic signals propagate at the speed of light."

"Flap your arms."

Koyanagi stared at him. "I beg your pardon?"

"Flap your arms. Like a bird. Like this." He did a Red Skelton seagull imitation to show him. "Do it as fast as you can."

Koyanagi looked doubtful, but complied. Singer could see he felt foolish. "That's enough," he told him. "Now, compare how fast you could do that to how fast a bird can flap its wings; or a hummingbird; or a bumblebee. You see? The smaller the scale, the faster the motion. Take my word for it, Masao. Nanocomputers are very fast because they're very small."

Koyanagi nodded. "I see."

Singer swiveled in his chair and faced the Japanese. "All right, old son, spit it out. You didn't stick around for small talk. What's eating you?"

"Eating me?" Koyanagi looked confused for a moment. Then he tilted his head back and sucked in his breath. "Ah, so." He hesitated.

"Don't hand me that Oriental bullshit," Singer snapped. "Out with it."

Koyanagi pursed his lips and considered Singer. "Very well," he decided. "There are some aspects of the design envelope that disturb me."

"Such as?"

Koyanagi pointed to the idea tree. "You have specified that the nanoma-

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chine be copy-proof and non-replicating.''

Singer nodded. ''What of it?'' he asked. ''If it weren't copy-proof, then any Jimmy or Jane could pirate it and undersell us. They wouldn't have any development costs to amortize, so — bingo! —there go our profits. As a former employee of São Paulo Biophysics,'' he added drily, ''you should appreciate the risk of piracy.''

Under patent law, such theft was illegal, regardless of whether or not the product were copy-proofed; but Singer didn't trust pieces of paper. He was more interested in preventing the loss in the first place than in calling it illegal afterwards. Besides, a New York court of appeals, citing the ''attractive nuisance'' doctrine, had recently ruled that the lack of copy-proofing constituted contributory negligence. Like leaving your car keys in the ignition; or like a rape victim wearing provocative clothing. Once again, the victim was at fault. Trust a New York court to discover that!

''Are profits so important,'' asked Koyanagi, ''compared to the benefits this machine could bestow on humanity?''

Singer laughed. ''Son, profits are always important. A business needs 'em the way any critter needs food. If it doesn't get enough, it dies. And second—'' His grin broadened. ''I like money.''

Koyanagi looked at him sadly. ''So I have heard. Is that all that this project means to you? Recovering your investment? What of serving mankind?''

''Serving mankind is how I recover my investment.'' Singer didn't like Koyanagi's implication. What was he, another head-in-the-clouds do-gooder? He felt his face flush, but controlled his voice. ''Me, I'm in business to make money; not out of altruism or scientific curiosity. You don't stay in business unless you offer people goods or services with the qualities they need. A lot of American businesses forgot that. They sold stock instead of products. That's why your folks undercut them. This nanny will satisfy a real need for space-based companies and the nuclear industry. There's always money in serving mankind. That's why I gave it the go-ahead.''

''But . . .''

''I'm listening.''

Koyanagi looked at him and took a deep breath. ''*Senhor*. I regret if I cause you discomfort. But I worry that your, aah, 'concern' for profit will put this product out of the financial reach of many who need it. Will we create two classes of people, the Immune and the Vulnerable, widening the gap between rich and poor?''

Singer shrugged. ''Of course we will, but what of it? How many solar panels can you find in Harlem? How many backyard windmills? Does that make solar energy elitist? Sure it does! But that's no reason not to do it. The rich always get first cut on any new technology. That's just a fact of life. What do you want me to do, give it away for free?''

''I am not suggesting that—''

''Because you're getting mighty generous with my money. Look, those who need the nanny will get it,'' Singer went on. ''The greedy power companies and space stations will include it as part of their workers' benefit package. The

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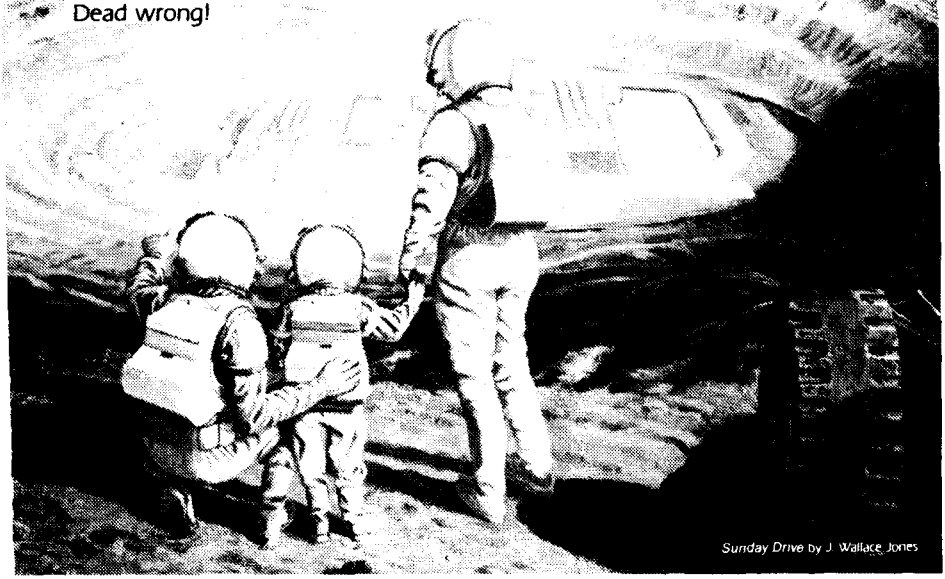

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unions will see to that, even if management is too dumb to realize the potential for reduced insurance costs."

Koyanagi flushed and Singer marvelled how the man could look both angry and embarrassed. "Dr. Singer, I . . . dislike argument. But what would you say to a mother living downwind from a mismanaged nuclear powerplant, whose child has died of radiation sickness because she could not afford your shots?"

"I would say that her community should have supplied it, just as they do fluoridated water." He jotted a quick note on his desk pad: *Water-borne vector?*

Koyanagi was silent and Singer looked at him. "What's the matter? Do you wish my motives were purer?"

"Frankly, *senhor* Singer-sama, yes."

Singer grunted. "Have you ever been poor? I mean, really hard-scrabble, ricket-ridden dirt-poor. Have you ever gone to bed hungry?"

"No," admitted Koyanagi.

"Then shut up about my motives! You don't know what you're talking about. Why should I care about the respect of future historians? That and 75new¢ will buy me a cup of coffee. And not even Brazilian coffee, at that."

Koyanagi bowed slightly. "I see. Then the reason for the non-replication requirement is to assure repeat sales. Otherwise, a single injection would be sufficient for life."

Singer wagged a finger at Koyanagi. "Now, hold on there, Koyanagi-sama! Money isn't the only issue. I don't like to release self-replicators into the general public because they're too hard to control."

"*Sim*. We would not want an epidemic of radiation resistance to break out. If people could catch it from one another, they wouldn't need to buy your product."

Singer drummed his fingers on the table and said nothing. Masao was beginning to annoy him. Who did he think he was, coming in here with an idea—a very good idea, granted—and then trying to tell Singer how to run his zoo? Sure, it would be nice if everyone could have the nanny; and maybe someday the price would drop to where anyone could afford it. Until then, the books had to balance somewhere.

Koyanagi fidgeted, looked uncomfortable, then bowed reflexively. "I meant no offense, Dr. Singer-sama. It is just that the sound of the cash register is perhaps a little too jarring to me."

"Hunh. What sounds constitute music depends on whose ear it is. Maybe for you, it's the applause of your peers at some technical conference. But, son, *someone's* got to pay the rent on this shack."

"Yes, I see."

"And, Masao. Tell me one more thing."

"What?"

"Did you plan to refuse your share of the profits from this?"

Koyanagi stared at him for a moment. Then his eyes fell.

"No."

"Uh-hunh. I didn't think so. So, don't give me any of that holier-than-thou crap."

III

Singer took his seat at the conference table and watched Kalpit Patel set up

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the computer interface. Murchadha passed copies of their report around the table. Koyanagi immediately opened his copy and began reading. Singer glanced at the first page summary, then tossed it back on the table top. "So what is it, good news or bad?"

Murchadha handed the last copy to Dr. Peeler. "Yes," he said.

Singer cupped his chin in his hands. It was going to be one of those briefings. "Would you care to elaborate on that, son?"

Patel faced the group and cleared his throat. He looked at his notes and hunched his shoulders. Patel hated talking in front of other people, which was why Singer insisted on it. It was good training to do something you hated. He remembered Patel's first briefing, years ago. His hands had shaken so badly he could hardly read his notes.

Patel looked at Murchadha, who nodded and dimmed the lights slightly. Patel was more at ease when he couldn't see his audience. "As you know," Patel began, "Eamonn and I were given the assignment of simulating alternative design scenarios."

Singer wished people would not begin sentences with *As you know . . .* "Get to the point," he told them. "Can we do it or can't we?" Koyanagi looked up from his private perusal and blinked around at the group. He laid his copy of the report down, and listened with a troubled frown on his face.

"Well, Dr. Singer," said Murchadha. "We can and we can't."

Sometimes Eamonn annoyed him. He could carry that Irish act of his a little too far. He was a damn good nanomachinist and he knew it, but he tended to act like an eccentric. A prima donna playing a role. Hell, they were all prima donnas—including himself, Singer admitted. But he wondered if any of the others appreciated just how much money was already involved in the project. Sunk costs, regardless of whether the project flew or not.

"OK. Just skim the details. We don't need a blow-by-blow account. I assume all that's in your report. Just give us the straight skinny."

Patel dropped his eyes to his notes and discarded the first three cards. "We, ah, looked at several promising scenarios, but we will only present two of them." He activated a program and a graphic animation began playing on the large wall screen. Duplicate displays appeared on the smaller screens set into the table at each seat.

Singer watched a large, irregular blob fill the screen. It had hairy tendrils, and darker splotches within it, like some creature from a bad "sci-fi" movie. A cell, magnified many times. A nanomachine, represented by a miniature black box, swam up to it. It passed through the cell's membrane, closing it up behind it.

"The nanny," said Patel, "has recognized the cell as being abnormally ionized."

The scene shifted to the inside of the cell, where the nanny was seen disappearing into the nucleus. Shortly, a cloud of nannies emerged and spread throughout the cytoplasm.

"The nanny checks the DNA library to determine the cell's proper configuration. Then it spins off slaves and inspects the cell top to bottom until it finds the damaged structures."

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Singer watched as the view magnified to molecular scale, showing a protein strand with a carbon group hanging loose where the linking electron had been knocked off. The black box crawled down the strand until it reached the defective part. There, its restrictor enzymes snipped it off and replaced it.

"Very nice," said Koyanagi. "That is exactly what I had in mind."

"I thought the nanny was not supposed to be a self-replicator," said Burton-Peeler.

"It is not, truly," Patel told her. "The slaves self-destruct once the repairs are completed."

Peeler studied the now blank screen. She shook her head. "It won't work," she decided.

"How do you know?" Singer asked sharply. Jessica was always too ready to criticize.

"Too many bits to bite," she said. "Isn't that right, Eamonn?"

"Tis beyond the state of the art," Murchadha admitted. "Tiny NIM can't handle the information load. Maybe in another couple years—"

"Maybe in another couple years we'll be bankrupt," snapped Singer. "Don't tell me what we can't do. Tell me what we can do."

"Well, there's this." Murchadha gestured to Patel, who activated the next simulation.

"This nanny is much cruder," explained Patel. "It kills the abnormal cells and lets natural reproduction replace them. We have based the model on the cytotoxic *T* lymphocytes, or 'killer *T* cells,' because its recognition system is more discriminating than that of other killer cells. It inspects the MHC—the major histocompatibility complex—on the target's surface. This will assure that the nanny does not attack healthy cells. It binds to a target cell only when the MHC presents abnormal antigens."

Singer watched the killer cell bind itself to the target cell and secrete nanomachines from its granules. "This nanny is based on the protein, perforin," Patel commented. "It masses an average of 70 kilodaltons and, in its monomer form, it will penetrate the target cell wall like a nail. Then, in the presence of ionized calcium, it polymerizes, barrel-stave fashion, creating a pore in the target membrane."

The protein molecule *was* shaped somewhat like a railroad spike, thought Singer, but its penetration reminded him more of a worm burrowing into the earth. Once in place, it popcorned duplicates of itself, forming a circle of "spikes." Water and salt from the intercellular space poured through the resultant pore into the body of the cell, which swelled like a balloon until it burst.

Murchadha, of course, had added sound effects to the simulation. The bang of the explosion caused the others to chuckle and even brought a smile to Singer's face.

"Hmm. What stops the nanny from polymerizing in the intercellular space?" asked Burton-Peeler. "Ionized calcium is plentiful there. I can imagine it filling up with these killer pores."

"Ah, and isn't that the beauty of it?" Murchadha answered her. "Only the monomer can penetrate cell walls. Once the little bugger polymerizes, it's harm-

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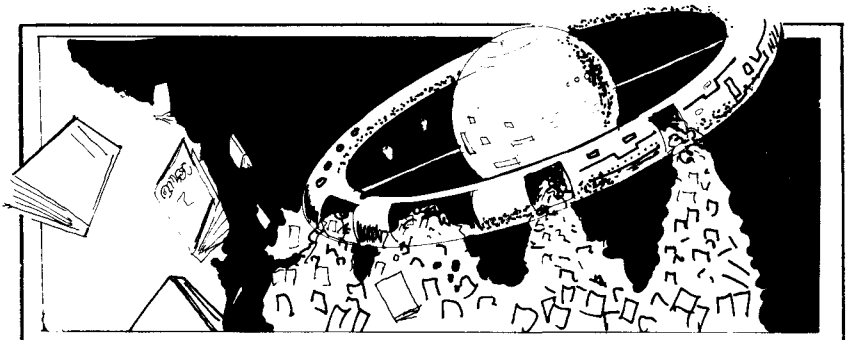

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less. Check Young and Cohn." He turned the lights back up.

Koyanagi looked troubled. "But, this method will simply accelerate the destruction of the radiation-damaged cells."

"Aye, Masao, that it will. That means they won't be hanging around, putting out the wrong chemicals or popping abnormal daughters."

"But . . ."

"But you wanted more," Singer told him. He looked at Patel. "So did I."

"And so did we," answered the microbiologist. "So what we did is—"

"—We combined the two concepts," finished Murchadha. "Poor Tiny NIM can't repair *all* the damaged cells. But, if we restrict it to certain tissues—"

"The nerve cells," guessed Burton-Peeler. "Am I right?"

Patel nodded. "Yes. Those cells *must* be repaired, but the others can simply be removed."

"Have you spec'ed any of this out?" Singer asked.

"No," answered Patel. "We think we can find the recognition system in *M. radiodurans.*" He looked at Koyanagi, who nodded. "The granule system, we'll steal from the *T* lymphocytes."

"You'll need the protectin protein, also," said Koyanagi, who had resumed his private reading of the report. He was flipping from page to page. Singer wondered if he was a speed-reader. "Otherwise, the perforin could attack the nanny itself."

Murchadha looked hurt. "We already thought of that. 'Tis in the appendix."

Singer made a decision. "All right," he told the group. "We'll go with the dual nanny concept. But I'll spec out the costs before we proceed. I've already done some preliminary market checks on the QT. I want to know if we can make this thing for a price people are willing to pay. If not, we'll have to terminate it now."

"Don't worry, Dr. Singer," said Koyanagi. There was an edge in his voice and Singer turned his head and looked at him. "Don't worry, Dr. Singer. Demand at the margin will be very elastic."

He woke up gasping for breath and sat upright in the bed. His heart thudded like a hammer in his ears. He looked around the darkened room, recognizing nothing. Shadows and shapes, ominous in the night. Panic and confusion. Where am I?

He took several deep breaths, calming himself. He wiped his palms on the sheets. What a dream.

"Pillow talk, Charlie?"

Singer looked over at his wife's side of the bed. Jessie was a shadow within shadows. "Sorry. Did I wake you?"

"No," she replied. "But I talk in my sleep. What's wrong?"

"Nightmare."

The sheets rustled as she rolled over. "What about?"

"The nanny, I think."

"Don't you remember?"

"It's not the sort of thing you'd want to remember." Confused images of the nanny's failure; of Jessie saying "I told you so"; of his mother boiling roots for dinner. Waves crashing on a midnight beach. "I guess I got spooked today when I ran the design envelope simulation."

"It didn't work?"

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"No. The limits of the design envelope projected a nanny too weak to be marketable." He shook his head, knowing she couldn't see him and hugged his knees to his chest. "We're running on a knife edge, you know. All we need is one big flop and we're finished."

"Do you think we should bail out now, while there's still time?"

"No. I'm going to rerun the simulation tomorrow."

"Oh?" He thought he heard surprise in her voice. "Why?"

"Because the journal data I used today must have been garbled. I looked at the raws and they didn't look right. I think some of the digits were scrambled during transmission. I'll get another copy from the data bank in the morning."

"Are you sure?"

"What do you mean?"

"I mean when you start questioning the data because you don't like the results . . ."

"I can smell spoiled preserves when I open the jar. Don't worry. I know it will work. We'll *make* it work. This is just a minor little glitch, is all. No more'n a wart on a bullfrog."

"You don't really think so. Not deep down."

He looked toward her, surprised. "Why do you say that?"

"Because it's one in the morning and you're lying awake in bed."

Singer couldn't think of an answer to that. Forgotten wisps of his dream fogged the corners of his mind with images he could not quite make out. He lay back down and put his arms behind his head and waited for sleep to return.

* * *

Singer watched the curve trace its way across the CRT screen. The rate of cell destruction increased as a direct function of the radiation level. That made sense. Careful gleaning of the biophysics data banks had yielded the data for the curve. And this time he had made sure the numbers were right, cross-checking and sampling at random against hard copy. The curve climbed toward infinity as it reached the right-hand edge of the screen. Singer grunted and entered a series of commands that would activate a simulation program. Murchadha's design for the nanny was still at the black box stage, but he had given Singer the working parameters to use for simulations.

A second curve, representing waste heat, replaced the first. In order to stay ahead of cell destruction, the nanny would have to work hard and fast, and that meant heat. Higher rad levels meant faster cell destruction, which meant more work for the nannies, which meant more waste heat. Which meant running a fever. Which meant there must be a limiting level.

Singer pursed his lips and rested his chin on his hands, staring at the screen. Then he sat back and pulled a stick of sugarless gum from his pocket. He queried the data base again and the heat curve grew a probability band around it. A given rad level produced a probability distribution of heat levels, due to random variations in the cell repair rates. The band shaded off from black—the fitted curve was the maximum probability—to successively lighter shades of grey.

Now, how much fever can a body take? He added a second probability

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distribution. Given the variation in human metabolisms, severe impairment or even irreversible brain damage could occur at different temperatures in different people. He decided on a 4σ safety margin for the design envelope. That gave him the highest level of waste heat that would be safe for the *entire* human population, the delicate individuals as well as the robust. Now match that maximum tolerable heat level with the upper edge of the regression band and the result was the maximum rad level that the nanomachine could safely handle.

For a moment he toyed with the idea of trading off the probabilities. After all, by making the vaccine "cool" enough to be safe for everyone he was, in effect, condemning more robust individuals, those who could tolerate a "hotter" vaccine. Make the nanny "hot" enough to protect Ernest Hemingway against every possible rad dosage and you could wind up cooking Emily Dickinson. Make it "cool" enough for Emmy, and Ernie could die if the rad dose exceeded the design limits of the nanny.

He could calculate the joint probabilities. It should be possible to solve the probability equations for minimum deaths. For any given design limit, there were Ernies and Emmys. Those for whom the design limit was too "cool" and those for whom it was too "hot." That had to be weighed against the probability of encountering a radiation level exceeding the design limit. Somewhere along the scale, the sum of those two components had to equal a minimum. He could trade off a small increase in the first category for a big decrease in the second, giving him a lower overall death rate.

But he aborted the program without running it.

Not all deaths are created equal. Any medicine could kill if it were too strong. And any medicine could kill if it were too weak. Sins of commission and sins of omission. But better ten deaths because of low potency than one death because of high. There was something especially terrifying about medicines that killed; and sins of commission were harder to forgive. Even *one* death due to an adverse reaction to the nanny could have severe financial repercussions. People would become afraid; refuse to buy the nanny. That had happened with the swine flu vaccine.

The public did not understand risk assessment. Not the difference between the α-risk and the β-risk; nor the relationship between them. People who refused to enter airplanes thought nothing of driving their cars. His equations would tell him the design limit that would minimize total deaths; but there was no term in the equation for human cussedness.

He studied the design limit. *Not too bad, after all.* Perhaps he was worrying over nothing. The safe limit was well above the level of the Chernobyl release or the usual solar flares. Good. At least the nanny would actually be able accomplish its goals. After the first run, he had been afraid that the safe limit would be too low. There was no market for a rad vaccine that only protected against sunburn.

Or was there? He made himself a note to check into the possibility of a nanosunscreen, perhaps ingested in the form of a tasty soft drink. If they could produce a "cold" version cheaply enough,

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they might be able to penetrate that market, as well. He chuckled to himself. *We may have tapped into a real gold mine here.*

The noise woke Singer up. He fussed for a moment, twisting and turning under the covers. Closing his eyes, he willed sleep to return. No good. Grumbling, he pushed himself out of bed. He struggled into his housecoat and wandered out to the kitchen, where he found his wife with her head in the refrigerator.

"Jessie?"

"Hi, Charlie," she said to the lettuce. "How does a midnight snack sound?"

"Not bad," he yawned. "You woke me up."

She looked at him. "Sorry. I was working on the identification problem and got so caught up with it, I forgot to punch out. I just now closed up downstairs."

Singer shook his head. "You're the only person I know who apologizes for solving a problem."

"Do you want a sandwich or don't you?"

"Hmm. Yes, but—" He pulled her away from the refrigerator and pointed her toward the table. "—you sit down and talk. I'll do the fixin's."

Burton-Peeler pulled a chair out and sat, smoothing her skirt. Singer began pulling odds and ends from the refrigerator.

"How does an error rate of one in a million million sound?" she asked.

"On identification? Not bad. How?" He gathered the tuna salad, bread, and other materials, and carried them to the sideboard.

"Well, I approached radiation sickness as a kind of proofreading problem."

"Proofreading?"

"Yes. Ionizing radiation causes typos."

He did a double-take and gave her a quirky grin. "That's one way of putting it."

"Yes. Radiation can alter the instructions on the DNA tapes. Our problem is to rebuild damaged cells faster than the ionizing events can wreck them. That's hard to do when the blueprints themselves are bad. Thank you." Singer set a plate in front of her with a tuna salad sandwich on it. The tuna was garnished with slices of onion and tomato and sprinkled with paprika, just the way she liked it. He had cut her sandwich diagonally. His own sandwich was much cruder, uncut and without embellishments. He could never figure out why she insisted on cutting sandwiches diagonally. It made no sense. He sat down across the table from her.

"Go on," he said.

"We have two issues, right? Cell replacement rate and faulty cells. Quantity and quality. Murchadha's nannies are the answer to the first. They'll be much faster than the natural body mechanisms. Repairing when they can; removing when they must." She took a small bite from her sandwich. "He hasn't worked out all the details yet," she said when she had swallowed, "but the idea is that his repair enzyme will crawl down the DNA chain by touch. Selective stickiness, he calls it. It reads each nucleotide in sequence and checks it against the blueprints *via* Tiny NIM. If they don't match, it uses its restrictor

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enzymes to tear the molecules down and rebuild them."

"Unfortunately," Singer commented, "the blueprints themselves may also have been damaged."

"Are you telling me my job, Charlie? What do you think I've just solved for you? That's where the proofreading comes in. Broken links in the DNA chains produce typographical errors in the genetic code. Hence, faulty cell reproduction, our second problem."

"So, how does the nanny know when the prints are correct?"

"Simple. We instruct the machine to work in triplicate. Imagine three DNA strands that have been randomly mutated by ionizing events. My program compares the nucleotides at the same addresses on all three strands. If they match, all well and good; but if they don't, majority rules."

"What if it's the odd one that's correct? Or if all three are different?"

She gave him a sour look. "Didn't you ever study statistics, Charlie? Of course you did, so stop asking silly questions. That would be like two or three independently recorded cassette tapes being garbled at exactly the same spot. It could happen, but it's not probable."

"One in a million million, you said."

"That's right. If you want better odds, you'd have to use quadruplicate or quintuplicate comparisons. That would slow down the nanny, though probably not enough to matter. The real limit is Tiny NIM's capacity. Triplicate's the best I can do for now without a larger nanocore. So if you don't like the odds, tough."

Singer nodded slowly. It was a nice solution to the problem; though he did wonder why it had taken her so long to develop it. The concept was simple enough. Possibly the execution was more complex. Technical details. All solutions seem simple in hindsight.

"There's one other problem, Charlie. I've checked over our idea tree and it isn't there. Nobody thought of it. Not even me." She took another bite of her sandwich. Singer wondered how anyone could manage to project smugness in the way she chewed. He knew she was doing it on purpose, to make him ask what it was she had noticed. And when she had said, "Not even me," she had meant, "Not even you, Charlie."

"All right," he said. "What is it?"

She looked at him innocently. "What makes the *nanny* immune to radiation?"

Singer opened his mouth and closed it again. "It's a small target," he said finally. "A lot smaller than a cell. The probability of a hit is pretty low."

"But not zero. Given a high enough particle density and a long enough exposure time and, sooner or later . . . whammo. And the killer cell 'aircraft carriers' are nanogiants."

"Well, so what?" he told her. "There'll be hundreds of thousands of nannies in the bloodstream! So what if a few of them are knocked out?"

"And the more nannies there are, the more likely it is that some will be hit. It's a Poisson process. You're missing the point, Charlie. What happens if a nanny is damaged?"

"Nothing."

"Are you sure?"

"What?"

"Are you sure that it's fail-safe? What if it starts 'repairing' proteins in-

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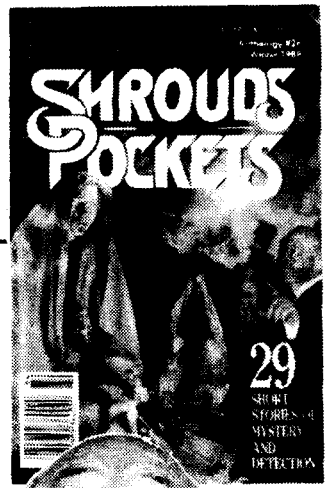

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correctly? Or what if the killer cells attack healthy targets? That will only make things worse. Remember AIDS? That was a natural nanomachine with bad instructions. The HIV would inject itself into the T-helper leucocytes and reprogram them, so instead of fighting infections, they would produce more HIV's."

Singer looked at her and pursed his lips. "You're right," he admitted at length. "I think we've all assumed failsafe modes without actually designing them in. Have you spoken to Eamonn or Kal?"

"Not yet. I'll catch them first thing in the morning." She hesitated.

"What is it?"

She studied her sandwich. "I don't know. Is it worth it?"

Singer looked at her blankly. "Is what worth it?"

"The nanny. So much of our capital is tied up in it and we don't even know yet if it will work. Maybe it's time to cut our losses."

"Of course it will work," he told her.

"How do you know? How many more problems like the one I just raised are lurking under rocks we haven't even thought of rolling over?"

"Every project has unanticipated problems."

"Maybe. But this project has such vital implications that—"

"All the more reason to push on. The profit potential was the reason we decided to go with it. How often do we get a chance to make a bundle on a product with such clear benefits and with no drawbacks."

"How—" She locked glances with him briefly, then looked away. "How do you know there are no drawbacks?"

Singer laughed. "If we find a flaw, we design it out. Besides . . ." And now it was he who avoided her gaze. "We're in too deep financially to back out now. It's got to work."

"But—" She seemed about to say something.

"What?

She touched her lips with her tongue. "But what if we come across problems we can't solve? What if we roll over a rock and find Godzilla?"

"Then we'll deal with it. Where's your optimism? We're a can-do bunch, aren't we?" He stuck his jaw out.

Jessie looked at him and shook her head.

"What is it?" He was growing irritated with her hesitancy. But it was late, after all, so he had to make allowances. She had put in a long day, and was tired and irritable.

"I just have a hunch. That's all. There's something so big that you haven't seen it. Some blind spot."

When Jessie had a hunch, it usually meant something. Singer picked up his own sandwich and stared at it. He wasn't hungry any more; but he ate it anyway. It was a sin to waste food.

IV

Singer rubbed his face in his hands, leaned back in his office chair, and glanced at the clock on the opposite wall. Quarter to six. How long had he been concentrating on the screen? Did he suppose that sheer will power could change the debits and credits around?

With a sigh of disgust he leaned forward and deactivated the bookkeeping

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program. There was no way around it. Cash flow was drying up. Aire Fresh was doing well. It more than covered their operating expenses—maintenance, power, utilities; but it was not enough to offset the research costs on the radiation nanny.

The Aire Fresh was an aerosol nanomachine that rearranged odor molecules into more pleasant-smelling configurations. With it, a person could fall into a pile of shit and come up literally smelling like a rose. It was selling especially well in areas beset by air pollution; and Murchadha had already suggested an industrial strength version to be installed in emission stacks and auto exhausts. Since the nanny actually uncoupled the harmful molecules, there were profound environmental implications.

None of which helped pay the bills today.

Dammit, he would have to go to the banks. He hated that. He hated borrowing money. Being in debt to another person twisted his gut into knots.

He rose from the desk and stretched his arms. He looked again at the clock. Time to close up shop.

It struck him that that could be taken literally, as well. If they did not get a cash infusion sometime in the next few months, he might have to close up the Lab.

The thought filled him with dread. The Lab was his life. Everything he owned was tied up in it. Without it . . .

Without it, I'll be where I was the first time.

And the first time had taken him out to the shore below Tom's River on a cloudless midnight in October. Is there any place as dreary and deserted as an October beach? He remembered how the sea breeze had felt on his face as he stood there staring out to sea. Black sky and black ocean. Black future. Restless breakers luminescent under the stars. The muted rush of the water as it stroked the land, patiently brushing rock into gravel and gravel into sand. His business was in ruins; being ground away by creditors as ruthlessly as the beach was being ground away by the waves. It would take little effort to dive into that surf and swim out so far he could never swim back.

It was the touch of the sea breeze that had stopped him, one bare foot in the tide. That and the sheering of the gulls. Or perhaps the distant lights of a tramp freighter working its way down the coast. Something in him rebelled against surrender, and he had made up his mind to succeed in spite of everything. And he had. He had turned his back on the beckoning ocean and had made his name a household word.

Yet, even today, it could bring out a sweat on him to remember how close he had come to taking that long swim.

He roused himself. *Tomorrow*, he thought. *I'll hit the banks tomorrow.*

He wandered to his office window and looked out at the shop. He grunted sour amusement. Everyone was working late. There was Kal quietly building simulations at his terminal. And Masao running microdisk after microdisk through his own terminal. Jessie and Eamonn were sitting at Eamonn's workstation, surrounded by his pumps and pipes, deep in discussion. Jessie was talking animatedly, gesturing with her

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hands, while Eamonn listened, smoking his briar and nodding occasionally.

What is wrong with this picture? Singer thought wryly.

Answer: why, with all this overtime, are we falling further and further behind the PERT schedule? We should be much further ahead by now. The project was moving as slowly as a legislature on tax reform. It was like swimming in molasses. Everytime things started to look good, Jessie uncovered a new problem. Or Eamonn's pumps quit on him. Or two molecular subassemblies would not fit together. They had had to redesign one particularly promising enzyme completely from scratch. *My fault,* he told himself. *Configuration control was my job. But I've been spending my time going over Peter's books taking out a loan for Paul.*

Patel called Koyanagi to join him. Masao looked up and saw Singer watching from the office window, and gave a little start. Then he shoved his microdisks into his drawer and rolled his chair across to Patel's side, where they huddled over the simulation.

Patel looked at Koyanagi, then at the screen. A CAD drawing of an elaborate molecular chain was displayed there. Patel crossed his fingers and pressed a button on the computer console. They watched the diagram fold up into a ball.

Koyanagi sighed. "Are you sure the angles on those molecular bonds are correct?" he asked.

"Trouble, boys?" Singer had come up behind them. He laid a hand on both their shoulders and stared at the tangled mess on the screen. "It doesn't look very pretty."

"Three months of work," said Patel, shaking his head. "It would do the job. It is the structure that gives *M. radiodurans* its resistance. It recognizes radiation damage. Mister Murchadha has a machine that will insert it into nerve cells."

"But . . ." prompted Singer.

"But it folds improperly," said Koyanagi. "It will not nestle with other bloodstream molecules."

"And it should," declared Patel. He stared at the screen, daring it to contradict him.

Singer tapped the screen with his fingernail. "So, why not roll your own?"

"I beg your pardon?" Koyanagi looked puzzled. Patel cocked his head and looked interested.

"Kal knows what I'm talking about. Tackle the problem like an engineer, not like a scientist. Build the molecule you want, *de novo*. If what you find in nature doesn't fold up right, then design something that does. Start with the final configuration and work backwards until you have the design."

"Yes," said Patel thoughtfully. "That could work. It has been done before on simple molecules. In fact, the first nanny designed from 'scratch' was a bee toxin built in 1983. You must have heard of it, Masao," he added, turning to his partner. "And even as early as 1979, Gutte and others were building short chains that nestled onto the surfaces of other molecules exactly as planned. This is only more elaborate." He paused and looked again at the screen. He rubbed his forefinger back and forth across his moustache. "Much more elaborate," he said.

Koyanagi smiled broadly. "If we

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must fold our own molecules, Doctor Singer, then I have every confidence in our success."

Singer blinked. "Oh? Why is that?"

"Because my hobby is *origami*."

"Dr. Charles Singer?"

Singer looked up from his newspaper. The mid-afternoon train from New York was nearly empty and Singer had been enjoying a quiet ride home following a round of visits to the banks. He had been trying to arrange for a line of credit to finance his "unspecified, but potentially profitable research program." Singer hated borrowing money. Fortunately—in a way—the banks hated lending it, at least on mystery collateral; so Singer was leaving New York with his principles intact, but his wallet empty.

When he looked up from his newspaper he saw a man standing in the aisle, balancing himself against the rhythmic swaying of the coach. The wheels of the car chattered underneath; and the telephone poles ticked past the windows. He was a thin man with a plain face, the anonymous kind that came off bargain basement racks. "Dr. Singer?" the man repeated.

"Yes, but if you're a salesman, I'm not interested. I don't do business on the train." To emphasize the point he raised the newspaper back to reading position.

"No, Dr. Singer. I'm not selling. I'm buying."

"I ain't selling, either," he told him through the paper.

"We understand you are working on a method of hardening human beings against radiation."

Singer put the paper down and stared. The thin man had taken the seat facing him. "Is that so?"

The man nodded. "Yes. That is what we want to talk to you about."

"I never discuss rumors," he told him and shook the paper open again.

"Don't play games, Doctor Singer. We *know* what you're working on."

Singer looked at him. "Are you threatening me?"

"Please calm down, Doctor," he said placatingly. "Perhaps, you don't understand. My name is Royce. John Royce. I represent the government."

"Whose?"

The thin man blinked, startled. "Why, ours, of course." He opened his wallet and showed Singer an identity card. A bad photograph of Royce peered earnestly from beneath the plastic. Governmental acronyms and numerology bordered the photograph. Office of Technology Assessment.

Singer handed the card back. "Hunh. Then you *were* threatening me."

"Not at all, Doctor. What I was trying to say is that we, the government, are very interested in your invention."

"Alleged invention."

The thin man looked pained. "Please, Doctor. Give us credit. There is no other possible explanation for the kinds of journal articles you have been accessing from the databanks. In combination, they add up to what we like to call a 'capability.' If you are not working on such a program, Doctor Singer, you should be."

"Information on my research plans is proprietary!"

Royce nodded and looked apologetic. "I'm truly sorry, Doctor, but sometimes

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the vital interests of our country force us to cut corners here and there on legal technicalities. National security, you know. The community interest must occasionally take precedence over purely private interests. The inconvenience is minor compared to what other governments do routinely." He leaned forward. "And you must realize, of course, that this new drug of your—"

"Medical device," said Singer automatically.

"Eh?"

"The courts have ruled that nanomachines of this sort are medical devices rather than drugs."

Royce waved his hand in irritation. "Never mind that," he said. "The point is that this new, er, device is of tremendous importance to the people of this country. So much so that the government is prepared to underwrite your costs of development and to take responsibility for its manufacture and distribution."

Singer had had a retort ready on his lips, but it died unspoken. "Underwrite my costs," he said.

"Yes." Royce was emphatic. "We are prepared to designate you as prime contractor to develop a radiation immunity device for the government, on a cost plus basis."

"Cost plus." Singer realized he was repeating Royce's words back to him. He shook himself. "I've never dealt with the government," he said gruffly. "I've always preferred the private market."

"As well you should, Doctor. Free markets are what made America great. But, the private marketplace is so uncertain. Profits are not guaranteed. A product might not even get to market. There are regulations to be met. Papers to be filed. The public must be protected—"

"I've dealt with EPA and FDA for many—"

"All sorts of bottlenecks could develop, bottlenecks that can delay your entry into the market." Royce shook his head in contemplation of bottlenecks. "Not only bureaucratic foul-ups—you know how mid-level drones love to demonstrate their importance—but Luddite lawsuits and protests, as well. And all the while your costs would continue to accrue, with no incoming profits to offset them. If things drag out long enough, the entire venture could become unprofitable. You and I both know of companies bankrupted, or of projects tripled in costs due to such circumstances.

"On the other hand—" And here Royce brightened. "—when the government is your customer, EPA and FDA filings have a habit of fast approval. There would be no hang-ups over petty technicalities. No long waiting periods to evaporate your profits."

Singer ran a hand over his mouth. "Cost plus," he repeated. "Cost plus how much?"

Royce waved a negligent hand. "That can be negotiated. Say twice your usual net profit?"

"And SingerLabs retains all creative control. No second-guessers from Fantasyland-on-the-Potomac. I would insist on that."

"Surely. Not everyone in the government is a mindless paper-shuffler. Our office is interested in results, not procedures. You produce for us and

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we'll restrain the i-dotters and t-crossers."

Singer thought it over. The government was a bad customer and a worse boss. But this looked like a way out of the financial corner they were in. Not only that, but the government could carry out the kind of widespread distribution Koyanagi wanted without cutting into the Lab's profit margin. "I tell you what, Mr. Royce. You come and see me in my office. Not on the street or on the train or anywhere else. Bring the papers and I'll look them over. I can't promise anything till I've seen the fine print."

Royce smiled. "Of course not. How about next week?"

"After I've reviewed your proposal," Singer said. "I'll bring it up with my Associates."

Royce frowned. "You consult your employees on such matters?"

"Why not? It's called democracy. Jefferson and Paine thought well of it. Besides, they're not exactly employees. They're Associates. Partners. They own shares in SingerLabs. I don't muzzle the oxen that tread the corn."

Royce seemed oddly reassured by that. "Deuteronomy 25, Verse 4," he said. "But you do retain controlling interest, do you not?"

Why was it, Singer wondered, that representatives of the Greatest Democracy on Earth were so shy about dealing with democratic organizations? Why did they always look for an autocrat? A sheik, a shah, a caudillo. Someone who could make the decisions. Was it a love of neatness and order? Democracy was inherently messy. "My wife and I do," he told Royce.

"Ah, your wife. Good." Royce smiled pleasantly. "There's no problem, then. I'll bring the papers by next week. Naturally, we would prefer to work with SingerLabs, rather than with some other nanotech firm. You have already done the preliminary research. But you know how competitive the nanotech industry is. So don't take too long on the formalities." He held a hand out, still smiling, and, after a moment, Singer took it.

Singer stood by his apartment window staring out at the Edison Tower and twisted his neck back and forth to get the kinks out. The tower was surmounted by an enormous light bulb and, beyond it, Singer had a glimpse of the first street in the world to be lit by electric lights. Edison's lab. Now long gone. Dismantled board and nail by Henry Ford and taken to Dearborn for his odd collection of buildings. Singer thought about how much had been done in that lab; done for the first time anywhere. There was a thrill in that, in doing something for the first time, that was unlike any other thrill imaginable. *"What hath God wrought?" "Come here. Watson, I want you." "My God, the damn thing works!" "Say, Ridley. There's somethin' wrong with this ol' machmeter." "The Eagle has landed."* "No, there was nothing like it, because there could only be one first time. He wondered what kind of tower they might someday build to him.

Suddenly, hands encircled his neck and began rubbing the tired muscles. He reached up and patted the hands.

"Jessie. I didn't know you were up

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here. I thought you were chewing the midnight bytes downstairs in the shop."

He tried to turn, but her insistent fingers held him tight. Her thumbs worked the shoulders and the base of his neck. Singer relaxed and enjoyed his wife's ministrations.

He had met Jessie in graduate school, where they had become both lovers and rivals. Lord A'mighty, that was an eternity ago. It was an affair of the mind that bound them to each other, a passion and a genius for genetics; because—Lord knew—there was little enough else to draw them together. He, the rough-edged boy from the ghost towns of the Kentucky coal fields; she, the polished, upper-class emigré from Devon. For three years they had traded top honors back and forth, with Singer being the last one holding the baton. Sometimes over the years, he had wondered whether there wasn't an undercurrent of that rivalry in their marriage. Whether Jessie had said "I do" in part so that she could continue competing with him. Maybe so. Singer told himself he didn't mind that. What was the old saying? A real man wants a woman who'll walk beside him, not behind him.

He told Jessie about the meeting on the train. About Royce's offer.

She let go of his neck and, after a moment, he turned and faced her. She was frowning. "Since when do you deal with the government, Charlie?"

"I know, I know. But the offer is tempting. You know how thin our margin is on this one. And Royce did promise hands-off."

Jessie snorted. "Tell the Red Indians about government promises. *They* even got them in writing."

Singer took a deep breath. Jessie was running true to form. "The banks turned us down, you know."

"We'll get by somehow, without taking the King's shilling."

"Cost plus."

"Cost plus hassle. It's just throwing good money after bad."

"It's government money."

"Then it isn't even good money. I'm still not used to red and blue bank notes."

It wasn't any use to argue. After twenty years, you'd think he'd have learned that. Jessie was as stubborn as a badger in a burrow. He turned and stared out the window once more. Without operating capital from somewhere, the Lab could go down the toilet. Didn't she understand that? No. When it came to money, she understood nothing. "You won't approve this contract, will you?"

"Approve? Goodness, no! That's inviting the camel's nose into the tent. Pretty soon the rest of it is in there with you. That mightn't be so bad, if you like camels, but they stink, they're foul-tempered, and they spit a lot."

"Dammit, Jessie, I've never seen you so negative as you've been on this project. You're not pulling your weight, you know. Not like Masao or Kalpit. They're putting a lot of skull sweat into this. You're just coasting. You hardly participate at all in our brainstorming sessions. And it seems as if every point you bring up is an objection, or a roadblock, or it exaggerates the difficulty or complexity of the project."

"Have any of my points been invalid?" she shot back. "Dammit, the

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project *is* difficult and complex, and wishful thinking isn't going to simplify it one whit. Pointing out the pitfalls doesn't make me an enemy. What about that fail-safe issue I raised?"

"We've got a consulting topologist working on it. But that's not the point—"

"Bloody hell it isn't! Charlie, you were never a nixon, someone who thinks every question is opposition. The fail-safe business had to be raised. You know that. You'd have raised it yourself, if you had thought of it. But you didn't. And that makes me wonder if you can see clearly on this one."

"What do you mean by that?"

"I mean you are so obsessed with our financial predicament that you can't see the real issues. You want this project to succeed—"

"Don't you?"

"You want this project to succeed so much that you think that means it *will* succeed. That there *can't* be any problems. And that makes everyone who points one out into some sort of traitor. Well, wishful thinking is no substitute for hardheaded engineering."

"You've got to think positive," he told her.

"No. You've got to think negative. If you always have your eyes on the stars you don't see the pitfalls under your feet."

"What pitfalls? Name them!"

"I have, dammit. Read my reports. But you've got to think of some of them for yourself. Don't expect me to do everything on this project."

Since Singer had been thinking precisely the opposite, her protest sounded funny. He snorted and flashed her a wan smile over his shoulder. "Royce seemed to think that I controlled your vote." Royce, he reflected, was probably not married.

"He what?"

Singer turned. "When I told him that you and I together held controlling interest, he seemed to take it that *I* held controlling interest."

She snorted contempt. "Where does he come from, then, Iran? Should I veil myself?" She glared at him, arms crossed.

He shrugged. "It wasn't me that said it. Come to think of it, though, when I quoted Scripture to him, he did come back with the chapter and verse."

"A Sawyer-ite, then." She waved an arm in dismissal.

"And," Singer said patiently. "a bona-fide government flunky. And . . . Look. He was very polite and apologetic. Never came right out and said so, but I got the very distinct impression that it was his deal or no deal."

She scowled. "What do you mean by that?"

He left the window and walked to the sofa. He sat and ran his hands over his face. "I don't like the government any better than you do. You know that. There's something about power that tempts people to push its limits a little further out each time they exercise it. Look at the way presidents have started wars, even though the Constitution clearly gives that power to the Congress. Royce dropped little hints: about using the reg agencies to keep us off the market; about leaking our project idea to NanoTech or General Molecule. It was the old carrot-and-stick approach. Do what we want, and we'll shower you

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with gold and silver. *Don't* do what we want, and you get diddly squat."

"So that's why you want the deal."

"Dammit," he said, pointing a finger at her. "The offer would have been tempting, regardless. We need the money."

"Then why the *Angst?*"

Singer paused with his arm outstretched. He hesitated, and the arm dropped slowly. "I didn't like his approach. It was a blatant appeal to my greed." He stuck his hands in his pockets and slouched in the sofa. "Are my motives so transparently simple?"

"Since when do you let your emotions interfere with making a buck?"

"Since when have you complained about making bucks?" he retorted.

She was silent, her eyes cast down. The silence grew in the room. "Charlie?" she said after a while. "Do you recommend that we accept this contract?"

Singer grunted. "Cost plus if we do; nothing if we don't. What do you think?"

"Beware of Greeks bearing gifts. Especially government Greeks." She turned and walked to the window where Singer had been earlier. He could see the tower over her shoulder. She crossed her arms. The silence lengthened. "Well, you haven't convinced me," she said finally.

He sighed. "I didn't think I would." He wouldn't look at her. "Jessie, without this money, the project is dead. Maybe the Lab is dead, too. If that doesn't mean anything to you, it does to me. I don't need your shares to approve this you know. Masao wants this nanny so badly he aches. 'To benefit humanity,' " he mimicked the Nipra-zillian's voice. "And to benefit his own career, of course. The government will assure the wide distribution he wants, and we'll still get to make a profit. So, the do-gooder will vote my way. And between us, we can convince Eamonn and Kalpit. They'd like to keep their jobs as much as anyone. The four of us together out-vote you."

"Go ahead, then. Why bother arguing with me."

He did look at her then. "I said I didn't *need* your votes, Jessie. I never said I didn't *want* them."

"Hunh. Getting romantic in your old age?" She looked away, working her lips like a fish in an aquarium. "All right," she announced. "If everyone else agrees, *maybe* I'll go along. But, Charlie? Ask yourself one thing."

"What's that?"

"Why did they bother? As far as they knew, you were going to build these nannies whether they offered you a contract or not. They could have bought all the nannies they wanted at fair market prices. By giving you this contract, they get to buy the exact same thing, but at inflated, cost-plus prices. You've been telling me what SingerLabs gets by doing things Royce's way, *but what in bloody hell does the government get?*"

V

Singer celebrated the signing of the contract by letting Royce treat him to lunch; and, even though it was government money, Singer picked a moderately-priced restaurant in Perth Amboy. Habit. Never spend more than you had to to get what you needed. There was an upper limit on what he was willing to pay

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for food, even when someone else was picking up the tab; and he refused to pay extra for what he considered non-essentials, like "ambiance" or fancy dinnerware.

The restaurant was set on a converted sailing ship permanently moored to the dock in Raritan Bay, just off Front Street. *The Amboy Clipper*. It specialized, naturally enough, in seafood. The maître d', who was dressed like Captain Bligh, greeted them warmly and led them to Singer's usual table, one with a good view of Raritan Bay. They settled themselves into leather-padded captain's chairs. The waitress was also dressed nautically, though her uniform would hardly have passed muster on a genuine sailing ship—Singer thought of how she would look climbing the shrouds. Royce ordered shrimp scampi; Singer asked for the broiled seafood platter.

"I'm surprised," Royce said, when the waitress had brought them their drinks.

"Oh?" Singer sipped his manhattan. "At what?"

"Well," the government man gestured vaguely, "for a man of your fame and notoriety, you don't seem to attract much of a crowd. I would have thought that here in your own back yard, so to speak, more people would recognize you."

Singer shrugged. He stared out the window at the Bay. Staten Island was absurdly close; the Arthur Kill was little more than river-wide. To the south was a marvelous view of Sandy Hook. A scrubber ship was criss-crossing the Bay, cleaning up a garbage spill from the Kill by seeding it with plastic-eating nanomachines. Plastiphage had been one of his first inventions, and the one that had made him famous. The view of the scrubber ships was one of the reasons why he liked to eat here so often. To remind himself what fame was worth.

Which was: not much, because General Molecule had pirated the Plastiphage design and marketed it themselves. He had sued, of course, but the courts had caved in because GM had the resources for immediate mass production of the nanny and the Public Welfare had demanded a Clean Environment Now. So, while Singer had the inventor's fame, GM had the retailer's profit.

"I try to keep my face out of the news," he said. "As long as I know who I am, it doesn't matter who else does. I'll leave the groupies to the athletes, musicians, and politicians."

Royce chuckled. "It's refreshing to talk to someone who's not all caught up with himself. You wouldn't believe some of the egomaniacs I've had to put up with in the Public Service."

Singer looked at him and grinned crookedly. "Oh, I'm an egomaniac, too. I just don't advertise it."

They ate their lunch in a half-silence. That is, Royce talked and Singer didn't. Royce's monologue generally covered his life and career, a topic in which Singer had less than consuming interest, so he listened with only half a mind. The rest of his attention was focused on how he would accelerate the research program now that federal money would be coming in. He wondered if he could buy sufficient stocks of research quality

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mutS and mutH without any of the big companies getting interested.

He speared a scallop with his fork and chewed on it thoughtfully. Scallops had the shape, taste, and consistency of rubber bottle stoppers, but he almost always ordered them when they were on the menu.

"I envy you, Dr. Singer," Royce was saying. "You don't know what it's like to be surrounded by drones. Too many of my colleagues in Public Service want nothing but more pay for less work. But, then," he sighed, "Gideon's Band has always been small."

"Gideon's Band?"

"Many are called," said Royce enigmatically, "but few are chosen."

"You take it seriously, don't you?" said Singer, a little surprised. "Public service, I mean. Usually, someone uses those words to me, I think he's a damn hypocrite. A passenger on the Federal Gravy Train."

Royce looked embarrassed. "I've always tried to give an honest day's work."

Singer laughed. "Then you're working for the wrong company, son."

"Maybe. Maybe not. Someone has to look out for the interests of this country. The whole country, I mean, not just good old Number One. Look at those people." He waved at the other diners in the restaurant. "Do you suppose any of them are genuinely concerned about anything beyond their own personal lives? Our waitress. Does she even feel a loyalty to the restaurant? I doubt it. She's worried about her paycheck and her tips; or maybe what her husband is up to; or whether the kids need braces. Maybe the maître d' feels a loyalty; he probably has a piece of the action. The owner certainly does. But do his loyalties extend beyond his restaurant? Does he concern himself with the county or the state or the nation, except to the extent to which they impact his business? I doubt it."

"Not everyone is so self-centered," Singer demurred. But he realized uncomfortably that he did not even know the names of his own representatives and what—if anything—they stood for.

"It's not the self-centeredness," said Royce. "We're all self-centered, fixed in the absolute middle of our personal universes. We all look out first for Number One. The Book says we must love our neighbors as ourselves, which implies that we must love ourselves first. No, it's the scope of that love. How far *beyond* Number One do our loyalties extend? To our Family? Friends? Employer? Profession? Hometown? Country?"

"I think you'll find that most people are loyal to their country."

"That's not what I meant, I don't mean that painless, motherhood-and-apple pie loyalty. The kind that waves flags, but makes no sacrifices. No, I meant, how many people really work at it? How many have the vision or the 'self-less-ness' to see where some private interest must be sacrificed for the common good?"

"And you do?"

Royce stiffened. "I like to think I have tried."

"A'right, a'right. Don't git up on yer high horse." Singer used the down-home accent he always used when he wanted to set someone at ease. "I wasn't accusing you of hypocrisy. What

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I meant to say was, how could anyone—however well-intentioned—know what was really for the common good?" He twisted in his seat and pointed out the window toward the bay. "You can't see Long Island from here; but out there is where the Shoreham nuclear plant used to be. The politicians never let it start up; instead they delayed it until it had become such a financial albatross that the utility caved in. Then the state stepped in and dismantled it, brick by brick. All in the name of the common good."

"As I recall, the plant was in too densely populated an area. There was no provision made for emergencies—"

"You mean the local governments refused to make such provisions."

Royce shrugged. "Have it your way. But the area was still too densely populated. People would have been subject to radiation leaking from the plant."

Singer laughed. "So instead they built coal-fired plants, and got irradiated anyway."

Royce frowned. "What do you mean?"

"That was my point, about knowing what is for the common good. Even when one's intentions are the best, it isn't always obvious, and sometimes the 'obviously right' solution does more harm than the problem itself. You see, burning coal releases carbon-14 and radioactive thorium." He made a mental note to market the nanny to coal plants as well. "Coal plants put out more radiation every day than nuclear plants do in a year. Yet, there are stringent limits placed on the one, and none at all on the other. Do you know what that means?"

Royce looked puzzled. "What?"

"It means that the target of the regulation was not dangerous radioactivity. The target was the nuclear industry."

Royce pursed his lips and looked uncertain. "Not necessarily," he said. "It might mean that the lawmakers were ill-informed. They were trying to do the right thing. Trying to protect the people. If they had known that about coal, I'm sure they would have extended the law. After all, radiation kills. Everyone knows that."

Singer smiled his crooked smile. It was remarkable what 'everyone knew.' "Well, yes and no," he said. "We live in an ocean of radioactivity. We're surrounded by it and don't even notice it. Normal background radiation runs 100 rads a year; even higher in places like Denver. Take solar energy—"

"Solar energy?"

"Certainly. That's a nuclear pile up there in the sky, or didn't you know?" Maybe he didn't, Singer reflected. Science education in the schools had been deteriorating for a long time; and a lot of pressure groups had succeeded in bowlderizing the textbooks so that Unpleasant Topics, like evolution or nuclear power plants, were mentioned only with politically discrete disapproval. "It's ninety-three megamiles away," he continued, "but it can still strike people dead."

"Mad dogs and Englishmen, anyway."

Singer chuckled. "Yes," he agreed. "But think about it. Solar radiation gives us skin cancer as well as sunstroke. Up in LEO or GEO—" He pointed toward the ceiling. "—on *Novy Mir* or the L4 complex, solar radiation

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is an even greater hazard than it is down here. Then there are bricks—''

''Bricks?''

''Yes. They're naturally radioactive, more or less, depending on where the clay was mined. And granite. Dental porcelain. Television sets. Even our own bodies: the potassium-40 in our blood. Radiation is everywhere. Burning tobacco releases polonium-210. A heavy smoker can accumulate 8,000 millirems a year—''

''You've convinced me, Doctor. I'm quitting!''

Singer laughed along with him. ''Yes, you should. And the Earth itself is naturally radioactive. It exhales radon gas, which can be trapped and accumulated inside houses, especially those 'environmentally sound' ecofast houses.'' He smiled ruefully. ''It's ironic when you stop and think about it, but environmentalism has put more people at risk of radiation-induced cancer than has the nuclear industry. The natural radiation inside some homes has exceeded the amounts released at Three Mile Island.''

''Hmmm. I see what you mean. We really can't escape radiation, can we? That makes your nanomachine all the more important.'' Royce stared past Singer's shoulder and scratched his cheek. He had a thoughtful look in his eyes.

Leaving the restaurant, they passed a group of protesters near the pierhead where the Bay Maintenance scrubber ships docked. The predators were carrying signs with the big e symbol of the Green Party. ''Mother Earth, Right or Wrong.'' One of the signs read: ''Our Earth! Love it or leave it!'' Singer got a chuckle out of that one.

''Damn radicals,'' muttered Royce.

''Oh, I don't know,'' Singer allowed. ''Their hearts are in the right place, even if their brains aren't.''

''It's brains that solve problems.''

''Agreed; but it's the heart that tells you the problem must be solved.''

Royce gave him a suspicious look. ''Are you a Green sympathizer?''

''Hell, no. Like I said, their brains aren't in the right place. And this new Gaea religion of theirs rubs me the wrong way. Mother Earth. They forget what a cruel goddess she was.''

''Paganism,'' said Royce.

Singer looked at him and considered saying what he thought of Sawyer-ism, too, but he thought better of it. It wouldn't do to bite the hand that fed him. ''Still, whether the ecosphere is 'alive and conscious' or not, you can't deny that it has a way of striking back when you don't treat it right.''

''Mother Nature,'' said Royce. ''Gaea worship. Paganism and feminism.''

Yes, thought Singer. And environmentalism, too. But also anti-science. And anti-evolution, because that contradicted their beloved Dogma of Entropy. How long, he wondered, before those commonalities led the two types of fundamentalism to merge? Sawyerites and Greens despised each other, but Singer could see how their shared enmity toward science could bring them together someday. Behold, I have given you stewardship over the Earth and all that is in it. Genesis 1, 28-30. Amen, brother. Amen.

They came to Royce's car, a black Olds. Royce unlocked the doors but

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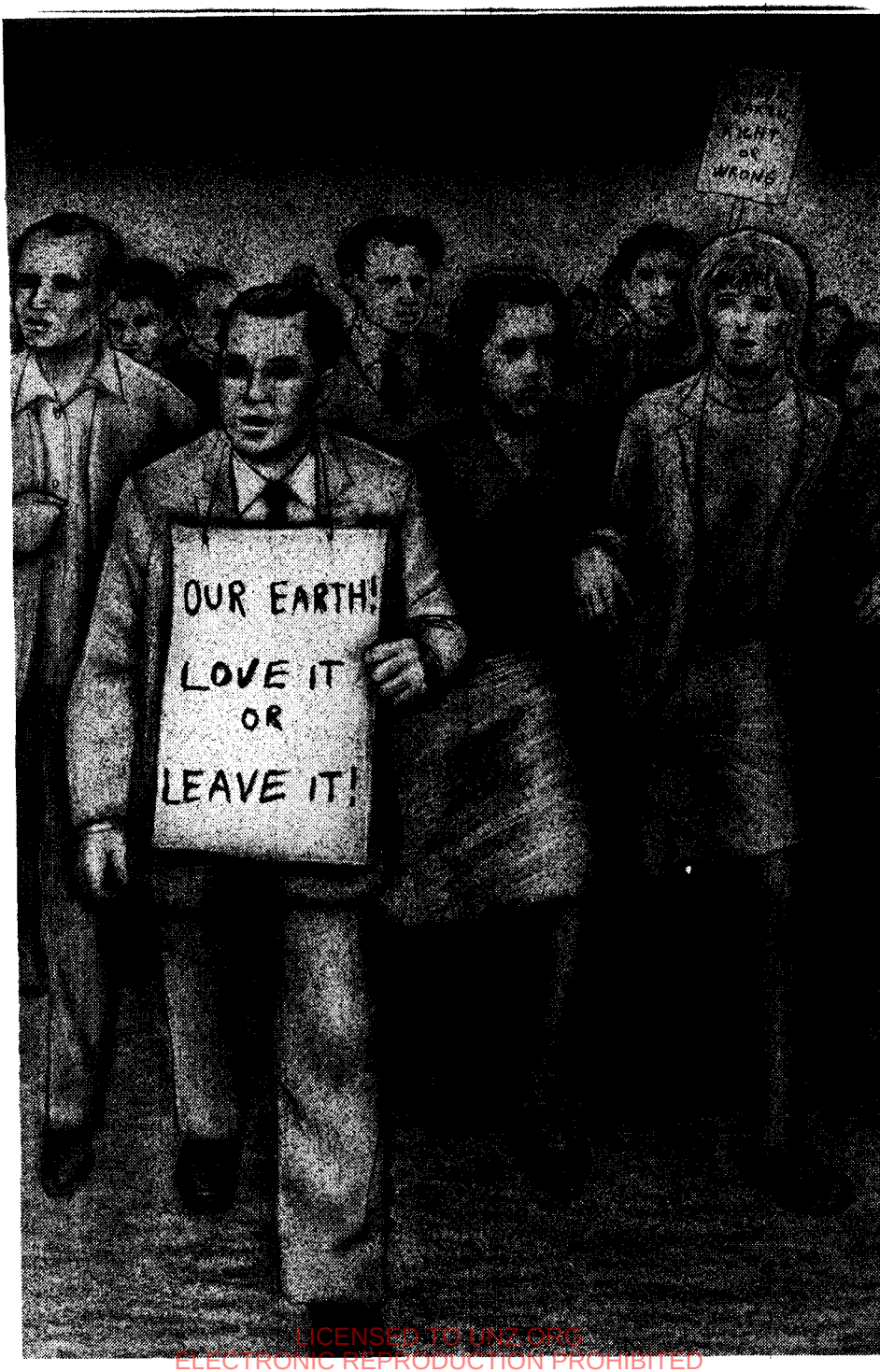

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paused before getting in. He looked back at the protesters. "One thing I don't get," he said.

"What's that?"

He pointed. "If they're in favor of cleaning up the environment, why are they demonstrating in front of the scrubber ship dock?"

Singer looked at where Royce was pointing. "I guess the idea is not to make the mess in the first place. I was reading where the number of spills has been increasing lately. They should be over at the Staten Island landfill to make that point; but I guess not as many people would see them there, or hear their message. Besides," he grinned. "It smells better on this side."

VI

It was late and Singer was closing up the laboratory when he noticed Eamonn Murchadha sitting at his nanolathe, a pipe clenched tightly between his teeth. He was staring at nothing in particular and the pipe was not lit. Singer wondered, as he sometimes did, how such a clumsy assemblage of pumps, vats, and reactors could machine components so ungodly small.

"Problem, Eamonn?"

The Irishman jerked in his seat and turned around. "Doctor Singer," he said, "Sure, you'll be giving me a heart attack, sneaking up that way."

"You had your Input/Output system buffered," Singer replied. "I could have marched through here with the entire British Army and you wouldn't have noticed. Which planet were you on?"

Murchadha's face fell. "This one, I'm afraid."

Singer scowled. Something was obviously troubling the young nanomachinist. He pulled a stool from under the lab table and perched himself on it.

"I see. Anything in particular, or just general Celtic melancholy?"

Murchadha took the pipe from between his teeth and inspected the bowl. He rapped it sharply against his left palm; then he took a tool from his pocket and began to worry the plug. Fragments of tobacco fell onto the table. "Tell me, Doctor. Have ye ivver thought about the implications of what we're doin' here? With the radiation nanny, I mean."

Singer frowned and cocked his head. "I take it you don't mean the obvious."

"That we won't fry any more cosmonauts or depopulate the Ukraine? No, *I didn't mean that.*"

"Then what?"

"The spin offs," he replied enigmatically. He inspected his pipe bowl again, and sucked on the stem experimentally. "You can't change human nature, you know."

Singer was puzzled. "Human nature? I'm not sure what you're getting at."

Murchadha sighed. "Neither am I. But . . ." He shrugged and looked off into the distance. "Supposin' you're the operator of a nuclear plant. You've got strict safeguards and procedures to follow. There are guards around guards around guards. Fail safes and 'Tell Me Thrice's.' And all because the danger is after being so great." He shook his head. "But what if the danger were *not* so great? What then? What if all those folks livin' outside th' perimeter were immune to accidental releases?"

"Hardened, not immune. They're supposed to be. That's the whole idea."

"Aye, and a noble idea it is." Mur-

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chadha smiled and looked at the ceiling. "Did you know there's many a policeman refuses to wear a bullet-proof vest? 'Tis a fact, it is. Flat refuses. They say the wearing of it gives a false sense of security. It makes a lad take chances."

Singer stirred uneasily. "And you think that if we give people a 'vest' for subatomic bullets, that they'll grow careless? I don't believe it!"

Murchadha shook his head sadly. "Ah, 'tis a touching faith in human nature that you have. It doesn't matter whether ye believe it or not. People are people. You can't change human nature. We might wish that folks were reasonable and logical and compassionate; but the sad fact of it is that they're not, and they never will be, God bless 'em."

Singer pursed his lips. A similar thought had crossed his own mind, when he had decided on designing the nanny to a "cooler" tolerance. Individuals might be reasonable; large groups were not. "But the vaccine isn't really a bullet-proof vest!" Singer protested. "It doesn't confer immunity. It raises the level we can tolerate above what we would expect from nuclear accidents. That's all. I've pushed the edges of the design envelope in simulations. There are limits. To the rad level. To the exposure time—"

"Ah, you know that, and I know that. But what will the folks out there be knowin'? Only that 'tis no longer so important to be careful. And Managers—business-trained managers, anyway—have taken short-cuts before, even without bullet-proof vests." He shook his head. "They don't understand, at all. They think maintenance and weld inspection and the like are overhead. They think they are *financial* issues." He pulled a pouch of tobacco from his shirt pocket and hefted it in his palm. "But that isn't the worst of it, not at all." He sighed and filled his pipe. " 'Tis an evening for gloomy thoughts, it is."

Singer sighed with him. When Eamonn put on his stage-Irishman act it could mean anything. "Then what is? Worse, I mean."

Murchadha was silent for a long moment. "Have ye ivver heard," he asked finally, "of the Washer at the Ford?"

"Who?" Singer shook his head. "No."

Murchadha nodded. "I wouldn't think so. Who has, these days? We've no time for myths anymore. Leastwise, not for the old myths. We've got new ones, we do." He tamped the tobacco into his pipe bowl with his thumb. Then he looked off, past Singer's shoulder. "It happened a long time go, they say, back in the time there was before there was time. The Daghdha, the Good God, was out walking on the eve of the great battle of *Magh Tuiredh* with the Fomorians. Taking the evening air, he was. *Feis Samhain* had begun at sunset." He paused and looked at Singer. "*Samhain* was the old pagan New Year. It began at sunset on the last day of October."

"You mean Halloween?"

Murchadha snorted. "All Hallow's Eve. Aye. And All Hallow's Day that follows. Sunset to sunset. That's all that's left of the Old Feast. It's still a Holy Day for Catholics, you know. At any rate, while the Daghdha is out walking he meets a woman doing her wash in the river. A good-looking woman, she was, with a fine shape wearing the

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bones of her. She makes the offer and he accepts, being a fine Irish lad as well as a god, and not wishing to seem ungracious. Afterwards, the woman promises her aid in the coming battle. So naturally the Daghdha laughs. 'Your aid, is it?'' he says. 'And what might that be?' Then he sees that the woman is not a woman, at all; but the Morrighan, the Triune Goddess, in her manifestation as Nemhain, the Spirit of Battle. He sees in her eyes death and skulls and rotted bodies. Decayed flesh dripping from the white bone beneath. She is the War Fury, that dreadful female who is seen just before a battle. washing the severed heads and limbs of those about to die.''

Singer shivered. ''The Morrighan,'' he repeated.

''Aye. The Phantom Queen, The War Fury, and *Badhbh*, the Raven of Battle. Three in One. We never needed Padraig to teach us about Trinities. The Three Morrighans she was called by those who feared her. And what Hallow E'en skeleton or witch's costume has ever captured the horror of Herself?''

''None,'' Singer agreed. ''But why was she washing the heads and arms?''

Murchadha turned and stared at his work. ''It was Nemhain's cleansing itself that brought death. The Washer at the Ford was also The Chooser of the Slain.''

''A chilling story, son,'' Singer told him. ''But what has it to do with our nanny?''

Murchadha looked up. With his thumb, he again tamped the tobacco firmly into the bowl. ''Tell me, Doc. What is the worst radiation problem of all? The very worst.''

Singer felt a spark of anger. He leaned forward. ''Quit playing around with me, Eamonn! Get to the point!''

Murchadha lit his pipe. It was a butane lighter and the sudden flare was so large and so bright that Singer instinctively pulled back and almost fell off the stool. Murchadha sucked the flame into the bowl and the tobacco ignited. He glanced sidewise at Singer.

''Nuclear war,'' he said.

''Nuc . . .'' Singer felt fear. He looked at Murchadha and added two and two. ''Are you trying to tell me that by making people more resistant to radiation, we'll make nuclear war more likely? That's absurd! Impossible! You can't really believe that!''

''I can believe anything. I'm Irish, remember? We're all fey. The Queen of Hearts could believe six impossible things before breakfast. Sure, she had no imagination at all. We'll be handing the politicians a bullet-proof vest for fallout. And they are no brighter than the utility managers, are they? Won't they wonder? Won't they wonder if this might not be the very edge they need? Oh, maybe not our own president, fine lady that she is; or the old first secretary over on the other side of the world. They won't throw the Big One, because they'd both be losing more than they could ever hope to gain. But what of folks like that al-Qaysar? Or the new Homeland Party in Japan. Or the Indians and Pakistanis? Or . . . Need I go on? How do you think their minds would run if they believed Nemhain had washed their soldiers?''

''But . . . But . . .'' Singer felt anger and frustration building in him. ''Dammitall! It's absurd. It doesn't mat-

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ter if people are hardened to fallout if the rest of the ecosystem isn't. We can't tailor nannies to every species on the planet. And, besides, there's more to nuclear war than radiation. There's the blast itself, and nuclear autumn, and the collapse of the health and food delivery infrastructures. An increased resistance to radiation won't help a man who's starving to death, or dying of infection. So, what you're saying doesn't make any sense."

"It doesn't have to. People make decisions based on the facts as *they* see them, not as you see them. And if they don't like the facts, well, they just explain them away." He glanced at Singer and his eyes flicked away. "Tell me, Doctor. Have ye ivver read Thucydides?"

"Thucydides? No. He was an ancient Greek, wasn't he?"

"So he's not 'relevant' to modern times?" Murchadha sighed. "Why did our monks bother saving all that stuff?" He shrugged. "Well, this Thucydides lad, he wrote once . . . Let me see if I can remember how it goes." He tilted his head back and closed his eyes. "He wrote: 'Their judgment was based more on wishful thinking than on sound calculation of probabilities; for the usual thing among men is that when they want something they will without reflection leave that to hope, while they will employ the full force of reason in rejecting what they find unpalatable.' " He opened his eyes and looked at Singer.

"Remember," he continued, "these are politicians we are speaking of, not technicians. They are not used to reason. They live in a world where the words on a piece of paper are reality and everything else—matter and energy and physical laws—are only abstractions. They judge things by political 'agendas' or 'bottom lines.' They don't ask whether something be true, but only whether 'tis consistent with their political philosophy, or their investment strategy. They don't understand any of this. Nary a corporal's guard is technically trained. Nuclear bombs are only large firecrackers. They play children's games, chattering about throw weights and windows of opportunity and numbers of deliverable warheads. Deliverable? As if they were speaking of postal packages. EMS pulse? Nuclear Autumn? The collapse of the health care system? Unreality. It cannot be true, because they do not want it to be true. Only theories, they say. The theories of weak sister scientists with politically suspect beliefs. As if a neutron cared what ideology a man professed."

Singer was silent, taken somewhat aback by the vehemence of Murchadha's speech. He waited for the man to continue. When he did not, Singer spoke into the silence. "You could be wrong," he said carefully. "You're probably wrong."

"Aye." Murchadha blew a cloud of bluish smoke toward the ventilator. "I could be, at that. But I could be wrong believing the other way, too, now couldn't I? On the whole, I'd rather worry and be wrong. It's me duty, you might be sayin'. Me duty." He smiled thinly, as if at a joke.

"Your duty?"

"Sure, and is Murchadha not the Gaelic form of Murphy?"

His sleep, when it finally came that

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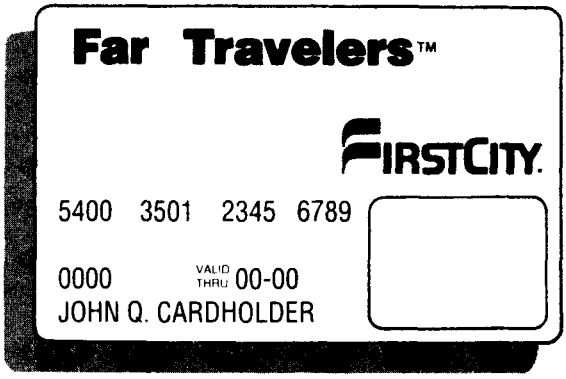
The Shape of Things to Come



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night, was troubled, disturbed by dreams whose meaning he could not quite discern. A part of him knew he was dreaming. He was inside himself and watching himself from afar at the same time. Sounds had a peculiar, muffled quality to them.

He found himself in the laboratory, but the laboratory looked somehow like the old cabin he grew up in. The floor was hard-packed dirt, and he was barefoot. Everything was backlit by a strange sourceless lighting. Jessie and the others were sitting at their workstations, intent on their work, and when they moved, it was in slow motion. They ignored him as he walked through. "How is it going?" he asked and heard his voice echo as if he were in a vast cavern.

Patel shook his head slowly. Left. Right. Left. Right. He held an intricate Tinkertoy molecule in his hand and he showed it to Singer. "It should fit, but it doesn't." He tried to jam it together with another Tinkertoy structure and they both fell apart into sticks and balls. Patel stared at the wreckage and wept.

Koyanagi was running discs through his terminal. His screen flashed in manic images that never lasted quite long enough to register on Singer's mind. "We must benefit humanity," Koyanagi told him, "even if it costs every penny you have."

Murchadha was sewing fancy, brocaded vests. He took out a tape measure and measured Singer. "Take a number. Line up." Royce was taking the vests from Murchadha and stacking them in piles by size. "Radiation is everywhere," he announced. "Everywhere. Everywhere."

A file of Green protesters goosestepped through the lab. Don't Go Against Nature, read their signs. Rad Nannies Kill! What If They Fail? Mysteriously, there was another door at the far end of the lab and, as the Greens filed out, Thucydides tied blindfolds around their eyes.

Thucydides was dressed in the waitress' nautical outfit. When the Greens were gone, he came over and tied blindfolds on Murchadha and Koyanagi and the others. They all laughed and began playing blind man's buff. Though Singer was not blindfolded, he could not connect when he swung his paddle at them. Yet, they never seemed to miss when they swung at him. They began knocking equipment over in their play and Singer tried to call out a warning but no sounds issued from his throat.

Thucydides stood before him with a blindfold and said something. It was Greek to Singer. The blindfold came up and over his eyes and everything went impossibly black. Singer stumbled forward, laughing. "Where is everyone?" He felt færie fingers groping in his pockets. He clapped his hand over his wallet, but the ghostly hand snaked in anyway and his pocket was suddenly empty.

Then his hand touched flesh. It was soft and yielding and covered with a gentle fuzz. He ran his hands up and down, feeling the smooth, familiar shape; the hills and valleys of baby-like skin. "Jessie?" He pulled her to him and for a wonder she came. Their lips met, suddenly passionate, and Singer realized that they were both nude.

He pulled off his blindfold and looked at her, and it wasn't Jessie at all but the Morrighan. He watched the soft, round flesh melt off her, into a red, sticky

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horror. The skull spoke to him through lipless jaws. "We've washed everyone," said a hoarse whisper. "We've cleansed the world." And a white flash scoured everthing of color. Singer tried to scream, but all that came from his throat was a low moan.

The shout that woke him was his own. He jerked upright in bed, his heart thudding, drenched in sweat. A feeling of *déjà vu*. He flicked his reading lamp to low. Beside him, Jessie stirred and said something unintelligible, but did not awaken. He took a long, slow breath to calm himself. *Another nightmare*. He looked at his wife's still form.

She was sleeping with her back to him. The curves of her body rose and fell with her breathing. He remembered how her flesh had felt in the dream. She began to roll toward him and Singer was struck by the sudden fear that the dream was not over after all, and that the face he would see would be the face of dripping horror.

He didn't want to know. He squeezed his eyes shut and lay down, facing away from her. As he waited another dread stole over him: that her skeletal hand would reach from behind and place itself upon his shoulder.

This is crazy. Knowing was better. He raised himself upon his elbow and glanced at Jessie.

And it was only Jessie, after all. Her face quiet and peaceful.

So, what did you expect? he chastised himself. This project is getting to me. But with the government funding coming, our worries will soon be over. He wondered if sleep would return and, if it did, whether he would dream again.

* * *

VII

The phone warbled the code that meant an outside call. Singer grimaced and, with a flourish, let the report drop to the desk. He glanced at Koyanagi. "Give me a minute, would you, Masao?" Koyanagi nodded and crossed his legs.

"Dr. Singer here," he told the mouthpiece.

"Hello, Charles." It was Royce. "I was wondering if I could borrow a few moments of your time."

"Only if you promise to give them back."

"What?"

"Nothing. What did you want?" he asked with a touch of asperity. "Everything is going fine. Just as it was two days ago. And last week."

"I'm not trying to ride herd on you, Charles." Royce sounded aggrieved. "I don't know your job well enough to give you instructions."

"That wouldn't stop some people."

Royce laughed. "I know. I know. I work with some of them. No, the government just likes to keep an eye on its investments. I'm only checking in to see if you have any roadblocks you need cleared. That's my job: to make straight the path before you. You're the quarterback in this game. Just think of me as your offensive line."

Singer sighed. He had no problem thinking of Royce as offensive. "No, we don't have any problems of that sort. Only technical hurdles that you can't help us with."

"Do you need more personnel? We can always round up a bunch of experts for you."

"No, John. You cannot solve research problems by committee. More

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than five or six people cannot decide when to eat lunch, let alone how to tackle a problem."

Royce laughed and Singer decided that the man's most irritating quality was his complete sincerity. He really did want to help; but he didn't know any way of doing that except to throw people and money at the problem. Well, he reflected, it could have been worse.

"Is that all you wanted? You'll be getting my regular progress report at the end of the week. If I do run into any bureaucratic snafus, I'll call you."

"Well . . . there is one other thing."

Royce sounded oddly hesitant. "What is it?" Singer asked.

"That Jap you have working for you? I'm afraid he'll have to go."

Singer frowned. He pulled the phone away and looked at it, as if he could see some defect with its mechanism. He glanced at Koyanagi, who was sitting calmly next to the desk.

Koyanagi was doing nothing. He wasn't fidgeting, or twiddling his thumbs, or looking around, or reading a magazine. He was simply . . . waiting. Singer had seen him do that before and it always bothered him, as if a person had to be constantly occupied at something. He wondered if it were some sort of Zen training.

He cupped the mouthpiece of the phone and motioned to Koyanagi to leave the office. "Give me a few minutes here, would you?" Koyanagi raised an eyebrow, then nodded. He rose and shook out his pants. "I will come back later regarding my report," he said. He closed the door behind him as he left.

"All right, Royce," Singer said into the phone. "What are you talking about?"

"That Koyanagi-san of yours. He's one of the roadblocks I was telling you about. It's either him or the appropriation. You can't keep both."

"What? That's absurd. The nanny was his idea in the first place. He came to me. He's our protein expert. I couldn't finish the job without him."

"Look, Charles, I just found out myself this morning." Royce sounded genuinely apologetic. "If it were up to me, I'd say what the heck. You can't always get real Americans, so you get by with what you have. But, you must see our point as well. With the economy the way it is, the government is extremely reluctant to let a contract on such a vital matter go through if it involves a foreign national. Especially a Brass Jap. There are powerful individuals on both the Senate and House science subcommittees who are disturbed. They had a hard enough time with your other employees."

"My other—what do you mean?"

"Well, one senator wanted to know why you didn't hire Americans instead of a mick, a limey, and a dothead. His words," Royce added hastily before Singer could speak, "not mine. I told him that Dr. Burton-Peeler was your wife and a citizen by marriage; that Mr. Murchadha was a naturalized citizen; and that Dr. Patel was a citizen by birth. That calmed him down somewhat, but it did create an issue over Koyanagi, who is most definitely an alien. We have enough problems with the Japanese-Brazilian co-dominium without having one of their nationals on a vital project of ours."

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"But—"

"And didn't he steal one of your designs when he worked for São Paulo Biophysics? SPB never paid royalties on that, as I recall. Another drop in the foreign exchange bucket. So it makes some of the committee members wonder what he's up to. It makes me wonder; and, frankly, Charles, shouldn't it make you wonder, too?"

Singer took a deep breath, unsure how to answer the man. Royce hadn't worked with Koyanagi like Singer had. Creating this nanny was Masao's life's goal. It was the nanny he cared about, not São Paulo.

Nor, come to that, SingerLabs.

He looked up at the office door and saw Koyanagi through the glass. He was waiting just outside for Singer to call him back in. Masao wouldn't care if SingerLabs developed the nanny or someone else; as long as it was developed. And as long as Masao had a hand in it. So why had he come to Singer? Why not stay at São Paulo and do it? *Because we're frigging geniuses here, that's why.* Because breakthrough comes before development. But if another lab could market the nanny at a lower price, making it more widely available to "humanity" . . . No, with the government handling that end, Masao had no concerns. They would probably make the nanny a civil right, find something in the Constitution that said everyone should have it. That was fine with Singer, as long as he got paid.

He thought there was something he should ask Royce, but he couldn't think of what it was. Something about distribution? Never mind. That wasn't his concern. The problem right now was what to do about Masao.

Singer turned back to the phone and swiveled his chair just a bit away from the door. "It comes down to this, John," he said. "My choice isn't between Masao and the nanny. Without Masao, there is no nanny. He is key to this project. Can you get your congress-critters to see that?"

"Maybe," Royce admitted. "I don't think they recognize the importance of individual excellence. To them, people are pretty much interchangeable. The senator will want to know why we can't use just any old biophysicist."

"OK, if they can't understand why 'people' isn't the same as 'headcount,' try this on them. If I dump Masao, he'll go straight back to São Paulo with everything he knows." *Could he do that?* Did his Brazilian patriotism outweigh his loyalty to SingerLabs? Singer remembered what Royce had said that day on the *Amboy Clipper*. Loyalty went outward from Number One in concentric circles. How far out did Masao's loyalties extend? Some Englishman — who?—once said that, given the choice between betraying his friend and betraying his country, he'd hope he'd have the decency to betray his country. By coming to Singer for the breakthroughs, was Masao betraying the Nippo-Brazilian co-dominium? Brasilia would certainly see it that way, but did Masao? *What is Masao's plan?*

"We'd have to start over," he told Royce, "and the Niprazilians would have a leg up. Our government couldn't stop Masao from leaving the country because the co-dominium would raise a stink about it and, if it stank bad

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enough, Tokyo might not reschedule our debt payments. Maybe your senator can understand that."

"I see your point. But, perhaps a compromise is possible. Surely, even if you need this man's services during the research and development phase, you could dispense with them afterward. The work then would be routine, wouldn't it?"

"Well . . ."

"And, of course, the government would be aware of the extra costs you would incur in the event of hiring and training another man to take this Koyanagi's place."

"And you would 'defray' those extra costs?"

Singer could almost hear Royce's smile over the phone. "Cost plus," he heard him say. "Cost plus."

Singer cradled the phone and stared at it. Absently, he pulled out a stick of gum and popped it into his mouth. Cost plus. How much for stringing Masao along, then dumping him? Thirty pieces of silver? What was the alternative? Losing the contract and the Lab. Throwing Eamonn and Kalpit on the street. He and Jessie losing everything they had worked to build. It is expedient that one man die for the whole nation. Was it also expedient that one man be fired for the whole Lab? He thought about it long and hard, but found no easy answers.

VIII

The report from the consulting topologist was four inches thick. Singer looked at the report, then looked at Patel. "Good news or bad?" he asked.

Patel smiled briefly. "It is very good news," he said, but he didn't sound very enthusiastic.

Singer pulled out a stick of gum and unwrapped it. "I could use some good news," he said. He stared at the report lying on his desk. How many pages thick was it? "Did she have to take so long saying it?"

He flipped to the back of the report and winced. As with most technical reports, it suffered from appendicitis. Twelve appendices in this one. He grunted humorlessly. It was probably better to put the Gory Details in an appendix than to have them strewn about the body of the report like the aftermath of the Texas Chainsaw Massacre.

He tried to read through one of the appendices. The derivation of some theorem or other. But he gave it up after a few lines. He was used to mathematics that used Greek letters, but general topology as often as not used Hebrew and Logic as well. This one-line equation here—it wasn't really an equation, like in calculus. It was more like a statement in logic. The one line would probably require an entire page of English. If it could be expressed in English at all.

And even the parts that appeared to make sense seemed to elude his grasp. "A topology that is both conjoining and splitting must be maximal splitting and minimal conjoining." "A space is compact if it is both H-closed and set-bounded." "Flynn's Theorem states that every function space in a class C^Y has a conjoining and splitting topology if the universal space of the class, U^Y, has such a topology." Hot stuff. He could picture topologists staying up late at night, flashlights on under the bed-

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sheets, unable to stop turning the pages. Anxious to see how it all turned out.

"It is not entirely mathematical," Patel pointed out. "The conclusions are rather simple and straightforward. Only two of the structures we have designed so far do not fail safe. Furthermore, the report defines an envelope of structures within which we must design in order to assure safe failures."

With a sense of relief, Singer retreated to the main body of the report and read through it quickly to make sure he understood it. When Jessie had raised the fail-safe issue with the group, Kalpit had suggested tackling the problem through topology. So Singer had retained a general topologist from the university—something the professor had found sufficiently intriguing in itself. Topologists were not in high demand for consulting jobs. But he remembered how the woman's eyes had lit up as he and Kal had outlined the problem. Singer thought she would have an orgasm right then and there. The topologist had spent a week in the Lab with Kal and Masao, learning about molecules, and had then disappeared to wherever it was that such people disappeared to, muttering about H-closed, B-bounded δ-structures and Harris proximity spaces.

A month later, she had returned smiling with the report they had commissioned and enough research ideas to burn out two dozen graduate students.

"The basic idea," said Patel, "is that molecular structures are points in a topological space; and 'mutation' is a topological operator that defines a proximity on the space. Two molecular structures are 'close' if one can be transformed into the other by a mutation. The 'distance' between two structures, Π_a and Π_k, is the inverse of the product of the probabilities of the chain of mutations that link them. For example, if Π_a could be changed into Π_k by means of a chain of three intermediate mutations, $\Pi_o \rightarrow \Pi_1 \rightarrow \Pi_2 \rightarrow \Pi_3 \rightarrow \Pi_k$, each having a probability **p**, then the distance between them is $\mathbf{p}^{-4}$. This metric creates regions in the space of all molecular structures."

It was the most pleasant sounding gibberish that Singer had ever heard. "Do you understand any of what you just said?" Singer asked with a grin.

Patel did not return the grin, which surprised Singer. "I understand it well enough to apply it," he said. "The set of structures that we developed for the rad nanny is a closed and bounded region that does not intersect any actively harmful structures. Except for the two instances I mentioned, no possible chain of mutations can change the nanny into anything but a broken nanny."

Ever since Jessie had raised the issue, Singer had been contemplating a host of Luddite "what-if" lawsuits, based on the chance that the nanny "might" malfunction. The sort of thing you would expect from people whose ideas of mutants came from Marvel comics. No probability greater than zero impressed that crowd. If it was possible, it had to be guarded against, even if the probability was one in a billion. *Do you mean to tell the Court, Doctor Singer, that you are willing to take* chances, *no matter how slim, with* human lives? *Why not,* he imagined himself responding. *We do that every time we drive a car.* Polite circumspection was not Singer's

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long suit. He knew he made a hell of a witness, and was the despair of his lawyers.

"You're right. This is good news," he told Patel, tapping the report with his forefinger. "We can actually prove that harmful mutations are impossible, not just improbable."

"Except for the two I've pointed out," Patel said.

Singer looked at him. "That's the third time you've mentioned that. Is something bothering you?" He realized he still held the unwrapped stick of gum in his hand and he popped it into his mouth.

"Bother me," Patel repeated. "I don't know. Perhaps it is only my imagination."

"Son, if you don't tell me pretty damn quick what's on your mind . . ."

Patel shook himself. He nodded at the report. "After I had read that thing and I went back over the structures we had designed, I became interested in the two that did not fail safe—"

"Can we redesign those two so they are safe, but they still do the job?"

"Charles, this is serious."

It was indeed if it meant that Kalpit was calling him Charles. "I'm sorry, Kal. You talk; I'll listen."

"Thank you. In answer to your question: Yes, we can redesign them, provided we modify a few other structures to compensate. Masao and I went through the entire system, component by component. But . . . one of those structures I designed myself and . . . and I could swear it had been altered."

Singer sat upright in his desk chair. Its spring threw him forward, catapult-like. "What? Altered how?"

"Charles, there is no other way. It had been altered deliberately."

"Wait a minute. Wait a minute. Do you know what you're saying?"

Patel looked at him, then dropped his eyes to the floor. He found something in the carpeting intensely interesting. "Yes, I know what I am saying. Some of the groups on the chains, they are not the proteins I put there."

Singer shook his head angrily. "Impossible. There are too many codons, too many bonds, even in the simplest structure. I know. I've reviewed them myself. You couldn't possibly remember what you put in each and every address."

"I do not," Patel admitted, still staring at the carpet. "It is not that. It is the . . . the æsthetics. An artist has a style, a certain way of doing things. And an artist recognizes his own style. A painter knows his paintings. An engineer knows his drawings. And I know my molecules." Patel looked up at him, his brow furrowed, his jaw firm. "I know my molecules," he repeated. "And one of them has been altered — even my own file copies—so that its failure would endanger the organism using the nanny."

Singer stared at him expressionlessly. "What about the other?"

"That would also endanger the organism. But it was Masao's design, not mine, so I do not know if it has been altered."

"Does Masao know? Did you ask him?"

Patel shook his head. "No. I did ask him if the structure was as he remembered it, but he laughed and said who can remember such things." Patel looked

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troubled and again would not meet Singer's eyes.

"All right. All right," said Singer, thinking aloud. "You say that one, maybe two structures have been altered—"

"Possibly more."

Singer felt offended. "You said two."

"No. Two would fail in a dangerous fashion. But, there have been other problems. Configuration problems. Interference fits on tolerances. Incompatibility between components. Little things, the kind of problems that we have always had on past projects. But more of them. Perhaps, too many more."

"And you think . . ."

"That someone is tampering with the design. To slow it down. Or to sabotage it completely."

There. It was out in the open now. A cold, horrible fact. No, not a fact, a speculation, Singer reminded himself. Kalpit had no proof. Nothing with which to confront anyone.

Configuration problems. Singer knew he had not been paying enough attention to the technical side. Money worries had been on his mind. Configuration control had been his job, and he had muffed it.

"These alterations that you suspect," he said. "They weren't out and out sabotage." Sabotage. From the French *sabot*, the wooden peasant shoe, which they had kicked into the gears and wheels of the strange, unfamiliar machines of the industrial age. "I mean, no one reached in with a hammer and smashed the molecule. They were altered, subtly, weren't they? They still performed their design function?"

"Yes. Only not as well. And they caused problems elsewhere. We were slowly painting ourselves into a design corner. Had the situation gone unchecked for much longer, we would have found ourselves with a nanny that was 95 percent complete; but with the remaining 5 percent impossible to realize."

Like a jigsaw puzzle whose last piece didn't fit. "All right. The million yen question: Who has the brains to do something like that?"

Even as he asked it, he knew the answer. All of them. Except maybe Eamonn. But, he saw the way Patel had dropped his eyes at the question, and it suddenly occurred to him why Kalpit was so wrought up; why he was so hesitant to mention his suspicions. Configuration control had been Singer's job. So maybe the problems were of Singer's making?

"It wasn't me," said Singer.

Kalpit looked at him and his skin flushed darker. "Nor I," he said. He clasped his hands together, as if he were praying, and laid his forehead on his knuckles. After a while, he looked up and his eyes were pleading. "Masao was my friend," he said.

Then you're thinking the same thing I am. Singer ran a hand across his chin. "Look, Kal. Don't say anything about this to any of the others. Not even Masao." He wondered. *Especially* not Masao? *Didn't they steal one of your designs?* Royce had asked. *Shouldn't you wonder what he's up to?* "Give me time to check into it," he said. "Maybe it's a misunderstanding, not deliberate." But it *was* deliberate. He knew it. He knew the work had been going too slowly. He remembered how the data for his design simulation had been

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garbled. How structures hadn't fit together properly. How they had had to redesign one enzyme from scratch. Sure, it could have been coincidence. Accident. And he and Patel could pretend to believe as much of that as they liked.

Patel nodded and left without saying anything further. Singer watched him go. Patel? Configuration control was Singer's job; and sooner or later, he would have discovered the sabotage. Patel knew that. Had he come forward simply to divert suspicion from himself? Perhaps. But what motive could Patel possibly have?

What about Masao? He had been standing just outside the office when Royce had called to demand his firing. Could he have overheard? Was he taking revenge? But Masao wanted the nanny more than anyone. More than Singer even, since, to Singer it was the profits that the nanny would bring that mattered. Still, he disagreed with Singer's marketing strategy. He wanted Free Nannies for All. And he *had* been a party to São Paulo's piracy, hadn't he?

Then there was Eamonn and his *Angst* about the side effects the nanny might have. Could his concern be deep enough that he would try to ruin the project? But Eamonn didn't have the expertise to do so subtle a job. Or did he? Just because the man wasn't a geneticist or microbiologist, it didn't mean he was ignorant. Nanomachining required extensive knowledge of molecular structures; and no one was more intimate with the *details* of their proteins than the machinist.

Or Jessie? His own wife? She had been dragging her feet on the project. She had not shown her usual flash and brilliance. Why, Singer didn't know. But lack of enthusiasm was not a motive for sabotage. Try as he might, he couldn't make the connection.

He couldn't make the connection with any of them. Except for Masao, they had been with him for years. He knew them. They wouldn't do such a thing to him. It just wasn't in them.

And that left Masao. The man from São Paulo.

Which would make it much easier to comply with Royce's demand.

Singer turned and spat his gum into the wastebasket. It had gone sour and tasteless. ■

CONCLUDED IN NEXT ISSUE

●ROBB'S LAW OF TECHNOLOGICAL EVOLUTION:
For every idiot-proof system devised, a new, improved idiot will arise to overcome it.
David Robb

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futures

Matthew J. Costello

My first visit to a movie set was less than glamorous. First, it was not anywhere near Tinseltown, but in the center of the peach growing region of the deep South, Gaffney, South Carolina. Second, the "studio" was the never-completed Cherokee Nuclear Power Station. The terrain, with exposed containment buildings and stark Quonset huts housing the costume, makeup, and other departments, was one of the bleakest landscapes I'd ever seen.

But there were two reasons I wanted to visit the set of Twentieth Century Fox's big-budget film, *The Abyss*. First, there was the director, James Cameron. Cameron directed *The Terminator* and *Aliens*, giving a new meaning to the word "relentless." *The Abyss* was his pet project, based on a story he wrote when he was seventeen. Set in a underwater prototype habitat, Deepcore — an oil drilling rig located near the Atlantic Trench—*The Abyss* looked liked it might be the ultimate underwater film.

In the movie, the underwater hardhats of Deepcore are forced to cooperate with a Navy SEALs team to rescue a nuclear sub perched at the abyss. Before they enter the sub, no one knows what has happened to it. There's a lot more going on here than just a rescue mission. There are, in fact, five different mysteries entangled in *The Abyss*.

When I arrived at the studio, I saw slides from the production, from the first models of Deepcore to the latest underwater shots. The main containment building was flooded with 7 million gallons of water. This tank housed the Deepcore set and the abyss. Another smaller tank held 2,600,000 gallons of water and housed the Sub Bay/Moon Pool, where the submersibles leave to explore the abyss.

The production, in Gaffney from July until December, dealt with large scale problems almost continually. One of the biggest problems was how to make Deepcore structurally rigid and still keep its six watertight modules underwater. It had to stay submersed while remaining strong enough to support its 20,000 pound weight.

Can-Dive Inc. supplied the submersibles Cab One and Cab Three. The small ROVs (Remote-Operated Vehicles), Big Geek and Little Geek, were refitted stock Benthos Engineering ROVs, similar to Jason Jr., the ROV that explored the *Titanic*.

Cameron directed the film underwater and his technicians created Clearcom, an underwater communications system. For the first time, scripted dialogue was recorded underwater while Cameron directed from a plastic-sealed script. All the actors, including Ed Harris *(The Right Stuff)* and Michael Biehn *(The Terminator)* were trained in open sea diving.

By the time I got to South Carolina, the cast and crew were desperately look-

(Continued on page 110)

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L. Sprague de Camp

THE APE-MAN WITHIN US

Civilized folk like to think they are very different from their pre-human ancestors. But how many of the differences are truly fundamental, and how many just variations on a theme?

In 1883, William S. Gilbert and the newly-knighted Sir Arthur Sullivan composed the operetta *Princess Ida*, based on Tennyson's long poem *The Princess*. The poem has the well-known line "The horns of Elfland faintly blowing"; the operetta burlesques higher education for women. In the operetta Lady Psyche, a professor at the women's college of Castle Adamant, sings:

A Lady fair, of lineage high,
Was loved by an Ape in the days gone by . . .

Spurned by the horrified Lady, the Ape

. . . bought white ties, and he bought dress suits,
He crammed his feet into bright tight boots,
And to start in life on a brand-new plan,
He christened himself Darwinian Man!
But it would not do,
The scheme fell through—
For the Maiden fair, whom the monkey craved,
Was a radiant Being,
With a brain far-seeing—
While a Darwinian Man, though well-behaved,
At best is only a monkey shaved![1]

Ignoring Gilbert's rampant sexism, how much Ape—or at least Ape-Man—is there in Darwinian Man? In Darwin's time the question was a joke or a blasphemy, but we can now discuss it intelligently.

People have long pondered about the distant past, when their forebears, they surmised, ran naked through the woods and turned over flat stones for their dinners. The baMangwato of Botswana had a legend that men were descended from monkeys. Then British missionaries told them that was all wrong; the baMangwato were descended from Adam and Eve like everyone else. The baMangwato were right the first time.

The Darwinian Revolution excited speculation about our distant progenitors. The subject became a lively topic for argument, litigation, fiction, and humor, as in *Princess Ida*. It became

1. Gilbert & Sullivan: *Princess Ida*, Act two. Gilbert obviously did not draw a modern biologist's distinction between apes and monkeys.

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involved in the old dispute about nature versus nurture, or heredity versus environment.

The question is really two: What were our pre-human ancestors like? And how much of their behavior persists in modern man? Are we programmed to act as our apish forebears did for millions of years, and if so to what extent?

When Darwin's *Origin* appeared in 1859, only two examples of proto-men were known. In 1848 a British army lieutenant found the skull of a Neanderthal woman (as it was later classified) in a cave at Gibraltar. This was put away in a museum and forgotten.

In 1856, a skeleton turned up in Neander Valley, on the River Düssel. Much of it workmen destroyed, but a Doctor Fuhlrott salvaged a skull cap and a dozen or so bones and fragments. Some dismissed the remains as those of a freak until further discoveries proved Neanderthal men to be a separate human race.

This race had some primitive features: receding forehead and chin, bulging eyebrow ridges, large teeth, and so forth. The typical Neanderthaler was a stocky, short-limbed fellow from 148 to 166 centimeters tall (4 ft. 10 in. to 5 ft. 5 in., the females being smaller) and very robust and muscular.

Early restorations showed Neanderthal man in a crouching, apelike posture, with his head thrust forward. These were based on a skeleton found in 1908 in the cave of La Chapelle-aux-Saints. It turned out that this skeleton was that of an arthritic old man who could not help his simian slouch. Other Neanderthalers stood as straight as we do. At first they were put in a separate species, *Homo neanderthalensis*. But during this century opinion has swung around to classing them as merely a race of *H. sapiens*, whose distinctive features often occur in living men, notably among the Australoids.

Discovery of bones of intermediate types in Israel implies that the Neanderthalers did not simply die out but mingled with men of other races when these overran Europe. Hence their genes are still afloat in the human gene pool, though only rarely are enough combined in one individual to create a modern Neanderthaler. I once had the doubtful pleasure of meeting the late Tony Galento, one of the only two men to knock down Joe Louis. If Two-ton Tony had let his whiskers grow and wrapped himself in a bearskin, he could have walked into a Neanderthal camp without causing the least surprise.

In this century, fossils have been found of so many kinds of sub-men and pre-men that we now begin to see who is descended from whom. Back in the Miocene, 10 to 20 million years ago, in Africa dwelt small, slender, tailless primates who, like baboons, could climb trees but who lived most of the time on the ground. A skull found in 1948 and named *Proconsul* is either the common ancestor of man and the anthropoid apes, or something very close to it.[2]

During the next few million years —how many is disputed—one species,

2. W. E. Le Gros Clark: *History of the Primates* (1959), pp. 94ff; Vernon Reynold: *The Apes* (1967), pp. 100f. *Proconsul* is sometimes classed as a species of the related *Dryopithecus*.

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Proconsul or a close relative, split into several branches. Some became more arboreal, with longer arms for swinging from branches and handlike, grasping feet. Of these offshoots, some died out without issue. Of the survivors, the orangutan and the gibbons, the Asian apes, peeled off first. Later splits gave rise to three other lines: the gorilla, the chimpanzee, and man.

We can only guess how these common ancestors behaved, since we have no time machine to take us back to the Miocene with video camera, tape recorder, and notebook. We can, however, get a grip on the problem by examining the behavior of modern primitive men and the surviving non-human primates, or rather by reading what the experts such as Jane Goodall, George Schaller, and their colleagues say about them.

Apes share many characteristics with other mammals. The females are strongly attached to their young and will fight to defend them. The males feel less strongly about their offspring save as these young form part of the group or band, but they good-naturedly tolerate the young. The young spend much time in play, mostly imitating the things they will later have to do for a living. Much juvenile play, especially mischief-making, is a means of learning what they can get away with before an exasperated adult swats them.

Like most mammals, apes have a territorial instinct, either as individuals or as members of groups. Orangutans are solitary like tigers and other lone hunters. When a female is in heat, the nearest male comes swinging over for a brief wham-bam-thank-you-ma'am. Then he leaves and pays no heed to any resulting infants.

Gibbons form long-lasting pairs. Their pair-bonding instinct, if not so strong as that of hawks and eagles, is stronger than that of other apes; certainly stronger than in most human show-biz personalities.

Gorillas and chimpanzees usually live in bands of one or two dozen for the gorilla, and two or three times as many for chimpanzees. Abundance of food causes chimpanzees to cluster in larger numbers; so will the threat of predators such as lions.

Chimpanzee society is of the "fusion-fission" type. Members of a band assemble for the night, usually making beds of branches for themselves. In the morning they separate into smaller troops to forage. Common troops consist of a female with her infants and adolescent young, or four or five males without families. Troop size and membership are highly flexible.[3]

A squad of males often goes off to patrol the boundaries of the band's territory. If they meet a squad from over the border, there is noisy screaming and threats until the smaller squad retreats.

About half the members of a typical band are infants and young. The alpha male, the boss, dominates the band. When it is threatened, he tries to protect it by noisy bluffing, rushing towards the intruder with his hair on end to make

3. Jane Goodall: *The Chimpanzees of Gombe* (1986), p. 147.

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him look bigger, screaming, beating his chest, and throwing things. This behavior, during the previous century, got the gorilla an undeserved reputation for ferocity.

The alpha male may be simply the largest and strongest in the band; or he may be a smaller male with energy and aggressiveness enough to cow the rest. Or he may have a knack for making friends who will stand by him in confrontations. Or he may have a trick of showmanship, like Goodall's Mike, who promoted himself from low rank to alpha when he found that by banging two empty kerosene cans he could make a terrifying noise, like a youth seeking status by playing his boom box loudly.[4]

Evidently chimpanzees have been no more successful in finding a perfect method of choosing alphas than we have. Human beings have yet to discover a foolproof way of picking leaders. If hereditary monarchy has been known to bring forth heroic leaders like Elizabeth I, it more often produces a Charles the Simple of France, a Pedro the Cruel of Castile, or a Sultan Selim the Sot. Choice by a committee of the ruling party may turn up a Churchill; or it may empower a Stalin, who killed more people than Hitler. If popular election sometimes finds a Lincoln, it also elevates a monster like Hitler or an amiable airhead like you-know-who.

The sex habits of gorillas and chimpanzees depend much on the character of the alpha. Some alphas try jealously to monopolize the females of the band. Others tolerantly let their male fellows, or at least their friends among them, take turns at a female in heat, whose state is marked by a conspicuous genital swelling.

When the alpha tries to play a sultan with his harem, females often slip away when papa is not watching for assignations with other males.[5] Some males persuade a female to accompany them for months at a time, raising the chance that any infants then conceived will carry that male's genes. Elephant pairs sometimes go off on similar "consortships." A male may consistently prefer one female for mating; she may or may not show the same preferance for him.

Males may fight for dominance or for a female. Such fights are seldom fatal in the wild, because the loser submits or flees before he is badly hurt. In captive chimp colonies fatalities are commoner, because the loser can be cornered. Within the group, friendships form between an individual adult and another adult of either sex or any age. The two go about together and seek each other's company over long periods. Members of a family, especially brothers, tend to support each other in quarrels. Goodall reports a frienship of years' duration between a female chimp and a baboon.

The chimpanzee's DNA and other indications show it to be our closest kinsman. Its behavior also shows resem-

4. Jane van Lawick-Goodall: *In the Shadow of Man* (1971), p. 113. After divorce, Goodall resumed her maiden name.

5. Frans de Waal: *Chimpanzee Politics* (1982), pp. 168-78; George Schaller: *The Year of the Gorilla* (1964), pp. 136ff.

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blance by traits weak or lacking in other primates. One such trait is missile throwing by gorillas and chimpanzees. Chimps are ready to throw sticks, stones, clods, and turds at anyone they fear or dislike. The throwing that I have seen would not make them baseball stars; still Bamboo, the big, bad-tempered gorilla in the Philadelphia Zoo in the 1930s, could shy a clod underhand so accurately that the zoo put up a wire netting to protect the visitors. One clod struck the wire with a bang and burst into fragments right in front of my face.

Some chimpanzee traits bring them even closer. One is tool using. A chimp may pick up a stick to hit with or to pry open an ants' nest with. It may poke a straw into a termites' nest and, when the termites seize it, pull it out and eat the termites. Gorillas and chimpanzees quickly learn to use a pole to pull in a piece of fruit that is out of reach.

Sultan, a chimpanzee studied by Köhler in the Canary Islands during the Kaiserian War, proved himself an Einstein among apes. Given two bamboo poles and a piece of fruit outside the cage and beyond the reach of either pole, Sultan, after thought and experiment, inserted the thinner pole into the hollow interior of the thicker and got his fruit with this compound tool.[6]

Another trait is hunting and meat eating. Although apes are basically vegetarians, orangutans and gibbons also eat insects and birds' eggs when they can. Chimpanzees not only eat those things but also, in some bands, hunt and eat the young of other mammals, such as monkeys, bush pigs, and antelopes. A young chimp may make a playmate of a young baboon; but a mature chimp may seize a young baboon and kill it, usually by biting its skull or whacking it against a rock or tree trunk. Male chimpanzees have been known to steal the infants of other chimpanzee bands, and even unattended human babies, to eat.

Male chimpanzees are more likely than females to hunt. They are more aggressive (not having infants to protect), more competitive, more given to missile throwing, and more content to spend time alone than females.

Another trait is food sharing. When a chimp eats, others may approach and make ritual begging gestures. If the eater feels friendly, he hands out pieces of his repast. Such begging moves are part of a repertoire of gestures, including kissing, which among chimpanzees take the place of speech. Gestures of dominance and submission maintain the pecking order in the hierarchy. A male propositions a female by shaking branches.

Like human beings, chimpanzees enjoy rhythmic sounds and movements. A troop has been seen wherein one pounded a log while the rest hopped and shuffled about in a kind of proto-dance. It must have looked like what one sees at a disco.

More ominously, chimpanzees make war. For centuries philosophers have berated mankind as the only animal that sets out in organized groups to kill mem-

6. Goodall: p. 27; R. M. & A. D. Yerkes: *The Great Apes* (1929), pp. 356f.

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bers of other groups of the same species. They did not mean predation, as when a lynx kills a rabbit, nor the ritual fights between males for females, as when buck deer duel with their antlers. In such fights the weaker combatant usually runs before suffering serious hurt. They meant deadly group combat among conspecifics.

When my fellow science writers Ardrey and Tiger popularized the term "killer ape" for our prehuman ancestors, they were angrily denounced for "biological determinism" and other evil thoughts attributed to racists, fascists, élitists, and economic conservatives. The indignation of these advanced thinkers seems to have been premature.

Goodall, studying the chimpanzees of Gombe Forest, was dismayed to discover that they actually did make war of a sort. When a minority of the band seceded and moved away, the main group apparently decided that they were traitors and enemies and, over the years, set upon them when they caught them alone, and beat and bit them until they were dead or dying. This continued until the few surviving secessionists disappeared, either by death or by flight to a greater distance.[7] Men still pursue renegades and apostates from their own group with singular ferocity.

Now that we see how our closest kin behave, we can guess that if a trait appears among both men and chimpanzees, it is likely that both inherited it from a common ancestor, unless it evolved separately. By comparing the habits of primitive human beings with those of apes, we can make at least educated guesses as to how mankind has come to be what it is, keeping some traits from apehood with little change while modifying others, mainly by culture, to cope with circumstances.

Men still form groups, regarding those outside the group as hostile and organizing these groups hierarchially, usually with an alpha male at the head. Until the Industrial Revolution took over much of the heavy physical work, males dominated most groups because they were, on the average, bigger and stronger than females, as they likewise are in the great apes. Now that the Machine Age has somewhat devalued muscular strength, alpha females head many groups, proving as effective in dominating, organizing, and leading as males.

Human beings still hunt, dance, compete for dominance, shape things into tools and implements, form friendships, and gang up on outsiders as their ancestors did for millions of years. The young play; young males play more at fighting than females, while females are more likely to play at housekeeping and mothering. (As with most human behavior, these distinctions are not absolute or clear-cut.) Adult males may fight for a female. Among some primitive societies, such as the quarrelsome Yanomamö of Venezuela, such fights are the main cause of homicide.

Babies are born fearing nothing save loss of support, abandonment by the mother, and sudden loud noises. They readily pick up other fears from their

7. Goodall: Chap. 17.

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elders, especially fears of the very things that endangered their pre-human ancestors: snakes, spiders, high places, dark inclosures, thunderstorms, torrents, and strangers. Children do not develop such intense, easily-provoked phobias towards guns, knives, automobiles, or narcotics, which in today's civilization are far likelier to kill them. These fears are not inborn or inherited; what is inborn is a susceptibility to them. A toddler ignorant of snakes has no fear of one; but if its parents shriek and cavort at the sight, it becomes an instant ophidiophobe.

Men make war—not all the time or with everyone, but depending on circumstances. These circumstances include real or perceived threats from other groups or opportunities for gain by attacking others. They may go to war at the behest of their gods, such as those of the Aztecs; the Aztecs feared their gods would die unless sustained by the smoke of burning human hearts.

Thus the Comanches, promoted with the aid of horses from hunting-gathering savagery to the higher state of barbarism, lacked the skill to make things they wanted and that the sedentary peoples, white and red, had. So the Comanches raided to gratify their desires. The Blackfeet, on the other hand, became warlike from necessity, when other tribes got guns from the whites before the Blackfeet did and attacked them. To survive, the Blackfeet militarized their society and became the terrors of the Plains. But some primitive tribes have learned to get along quite amiably with their tribal neighbors.

Crowding, as in civilization, seems to increase belligerence. Reacting to the frustrations of civilization by heightened violence may be compared to the curious habit of captive gorillas, kept in small inclosures with nothing to relieve their boredom, of pulling out and eating tufts of their own hair. Both cases might be considered *normal* reactions to *abnormal* stimuli or circumstances.

Pre-men were probably less warlike than the true men who followed because there were fewer of them. Game animals and edible plants were so common that widely-scattered bands seldom competed. With the denser populations resulting from technological advance came competition. Each band staked out its territory and attacked trespassers. Outsiders could sometimes gain admission to a tribe if they approached it slowly, warily, and deferentially, like a wolf seeking admission to a pack or a lion to a pride.

Tribal consciousness, reinforced by stories of the tribe's descent from a mythical ancestor like Abraham, grew. Other stories made the tribe the gods' favorite. If the tribe wanted land occupied by others, their gods conveniently gave them title, as they did to the 17th-century British settlers in North America or the 20th-century Jewish settlers in Palestine.

Tribal consciousness may consider those outside the tribe as not fully human; in fact as animals to be hunted. A tribe's name for itself often means "the real human beings." In Polynesia:

. . . the members of a Marquesan tribe were more than ordinarily kind

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and considerate among themselves and viewed the eating of a tribe member very much as we view cannibalism. Their stories . . . reflect the same horror as our own tales of ogres. . . . At the same time, members of other tribes were eaten without a qualm. Although the eating of enemy warriors had certain elements of ceremonialism and revenge, alien women and children were eaten simply because they liked the meat. Members of other tribes were hunted much as pigs were hunted, and captives were treated with unconscious cruelty. If they had more captives than were needed for the feast, they broke their legs to prevent escape and kept them until they were needed.[8]

The growth of a tribe into a nation caused a scale effect. A system that works well enough for a hundred people may work badly for a thousand and break down completely for a million. The inborn, spontaneous altruism (in the special scientific sense of the word) that individuals show their near kin thins out when applied to unrelated fellow tribesmen, and vanishes for fellow citizens whom one has never seen.

To get people to act altruistically towards unknowns, the young are told myths and legends. Laws are enacted. Religions erect imposing structures of tabus and exhortations: Thou shalt not steal, not only from thy kith and kin but even from any fellow citizen. To make the governing machinery work, rulers ordain symbolic things and acts: standards, flags, anthems, regalia, and oaths of allegiance. Thus they try to persuade their subjects to show the same loyalty to the nation that formerly they automatically extended to the hunting-gathering band.

These expedients do not always work. A major problem of today is that in many nations, parts of the population persist in thinking tribally, claiming special status or privilege on grounds of descent from some ancestor, real or mythical; or of the immemorial superiority of their tribe; or of the tribe's former dwelling place; or of wrongs done to their ancestors by the ancestors of other groups. The result is endless, murderous strife, since each side is unshakably convinced that, as the old hymn says, "We are right and they are wrong." As Henri Bergson wrote:

Man was designed for very small societies. That primitive societies were such is generally admitted, but it must be added that the human soul continues to exist, concealed under habits without which civilizations could not have been created. . . .[9]

We might say that civilization struck our species a million years or so before we were ready for it. Nearly all contemporary human beings would make efficient hunter-gatherers. A substantial majority would probably make out well enough as Neolithic peasants. But most of them have simply not evolved to the point where they can comfortably cope with the crowding and enormous com-

8. Ralph Linton: *The Study of Man* (1936), p. 238.

9. Henri Bergson: *Les Deux Sources de la Morale et de la Religion* (1932), p. 24 (*apud* Toynbee).

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plications of civilization.

We are programmed to get along easily with a hunting-gathering band of not much over 100 in number. If the group expands, it tends to split into mutually hostile factions, since such a faction is nearer in size to the group that men's unconscious is comfortable with. As Aristotle said, every difference gives rise to a distinction.[10] A large population tends to split into factions on almost any pretext: racial, religious, linguistic, political, economic, or even sporting.

The commonest such distinctions are the most obvious: those based on race, costume, or speech. Where differences of race are negligible and the others not obvious, since one can change one's clothes, faith, or language, a dominant group may compel the members of dominated groups to maintain their separateness by distinctive dress. Thus in Islam the dominant Muslims sometimes compelled Christians and Jews to wear turbans of prescribed colors. Unless restrained by the central authority, these factions may fall into feuds and fight it out with all the gusto wherewith the Sioux and the Pawnees raided and massacred each other.

It is evident, then, that tribalism works to maintain indefinitely fierce inter-ethnic conflicts like those in Ulster, Palestine, Sri Lanka, and Rwanda. But suppose we could, by some yet undiscovered technique, abolish tribalism. Should we all be better off? Don't count on it. I suspect that the fading of tribalism promotes the short-term, quick-buck, bottom-line, live-for-the-moment, gimme-mine-now psychology, which seems to have waxed in American culture during the last decade. It says: "What has posterity ever done for me, that I should care what happens to it?" I need not belabor the long-term consequences of such a world-outlook, or its effects on our poor beat-up planet.

Human beings, especially males, also enjoy hunting, even when their quarry does not threaten them and they have no real need for its meat or other products. Every autumn, thousands of American males drag 20 or 30 pounds of gun, ammunition, and other equipment:

Over hill, over dale,
Through brush, through brier,
Over park, over pale,
Through flood, through fire,

in hope of getting a shot at a deer or other edible creature. They cheerfully put up with the discomfort and the risk of being shot by another hunter or dropping dead of a heart attack to bring home the meat, which they could get more cheaply and comfortably at the supermarket. They do it because it satisfies their primeval urge to hunt and kill game.

They compete for alpha position. An individual seems to have two sets of drives: one to become alpha; the other to follow one who is alpha. These drives vary, so that in one man the urge to lead is irresistible while another, with a weaker alpha complex, is content to follow. If all were natural leaders or all natural followers, a stable hierarchy would be impossible.

The alpha drive persists in civilization to an often bizarre degree. To some, money is the measure of alphahood.

10. Aristotle: *Politics*, V, 3 (1303b).

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Some of these, who already have more money than they could possibly spend on themselves or their kin in a lifetime, go right on, trying by dubious financial manipulations to amass still more. Ninety years ago, the acidulous Thorstein Veblen analyzed the efforts of the rich, of his time, to demonstrate alphahood by conspicuous consumption and conspicuous waste.[11] Many of the contemporary rich are still at it.

Modern man has one advantage. In a primitive hunting band, there is room for only one alpha. But an active modern man belongs to so many overlapping groups that if he cannot be the alpha of one, he can have a shot at becoming that of another, though it be only the local chess club.

The major differences between us and the apes arise from upright posture, articulate speech, and changes in family structure. It was once thought that the big human brain came first and uprightness second; so pictures of pre-men showed human heads on apish bodies.

Later finds revealed that upright posture came first, adopted by *Proconsul's* descendants when they lived on the open savannas of East and Southern Africa, as some species of baboons do today. Gibbons run on their hindlegs but spend little time on the ground. Gorillas and chimpanzees can walk on their hindlegs, but awkwardly; for serious locomotion they go on all fours, walking on the soles of their feet and the knuckles of their hands.

Uprightness enabled the creature to see farther over the grasses. It helped in stone throwing and club swinging. It facilitated carrying things; a pre-man, having found or shaped a club or stone to his liking, could take it with him instead of having to find or make a new one for each occasion.

An incidental result was the bulging human arse, since the powerful *gluteus maximus* muscles inside the buttocks gave the legs a strong backward thrust, which enabled the creature to sprint bipedally to pursue prey or to avoid becoming such. (My *glutei maximi* proved their worth when in 1960, in Uganda, I was chased by an angry hippopotamus. I ran faster than I had run in thirty years.) This anatomical feature probably accounts for the fact that most human beings copulate in a position quite different from that used by practically all other land mammals.

Uprightness permitted attacking larger prey. Before, the meat part of pre-men's mixed diets had been small, slow creatures like insects, mollusks, reptiles, and very young mammals, and of course carrion. When men learned to skin their prey with sharp stones, they found they could make a carrying bag of the skin, perhaps as basic an invention as fire or chipped stone.

Chasing larger, fleeter, and sometimes more dangerous prey demanded the higher coordination provided by speech. A major evolutionary jump, involving the neural connections between the brain and the organs of speech, made this possible. The chimpanzee has a repertoire of cries indicating emotions, in-

11. Thorstein Veblen: *The Theory of the Leisure Class* (1899). Veblen pronounced his given name in the Norse manner, approximately TORSH-tun.

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cluding a shriek to celebrate the pleasure of orgasm: but these seem to be instinctive. Although both chimpanzees and gorillas can master fairly complex communication by sign language, with over a hundred signs, attempts to teach chimps to speak have come to nought.

The complications of speech and the more complex coordination involved in hunting big game, without the built-in killing equipment of the lion, required much bigger brains to provide all the necessary millions of neural connections. From this development came all our logic, science, history, philosophy, literature, drama, law, and religion. It also made war much better organized and more efficient.

Both sexes learned to speak; but the different ways they used their new skill is still reflected in their speech (with wide individual variations). Men's speech evolved as an aid in hunting. Necessarily it was curt, condensed, precise, and concrete: "Hey, Ug! Quick, get behind that rock on the right and spear the buck as I drive it towards you!" Unnecessary chatter was not tolerated because it might alert the game.

Women's speech was mainly used to keep the group harmonious and the infants under control, while the women foraged for vegetable food or worked at domestic tasks around the fire. So it became garrulous, diffuse, and imprecise, dealing not so much with objects, places, and actions as with feelings, relationships, and personal matters. These differences persist, to the exasperation of many otherwise happy couples. Men still complain of their wives' loquacity, while the wives, *au contraire,* complain of their husbands' taciturnity.

Thinkers have long wondered at the human bent to believe the most fantastic fictions, such as those that form the basis for most cults and religions, if presented in a forceful, aggressive, dogmatic manner. It probably goes back to our pre-human ancestors. Suppose you were out hunting with cousin Ug in the Pliocene, and Ug says:

"Hey, there's a sabertooth stalking us behind those bushes! Up a tree, quick!"

If you took that statement in a properly skeptical scientific manner, you would reply: "Wait a minute! Where's your evidence? How do you know it's a sabertooth? How do you know it's after us?" But by then you might be dead.

The larger brain required the skull to grow proportionately more after birth, since its size at birth was limited by the diameter of the mother's pelvic girdle. This meant greater helplessness and longer infancy, which kept the mother from being an effective huntress. Hence a human mother had to care for her infant more exclusively and for longer than would a chimpanzee or gorilla mother.

This change in turn required changes in sexual patterns. Since the female was disqualified from hunting for most of her life, sexual division of labor sharpened. The men not only defended the band but also brought in most of the animal food, while the females specialized in the vegetable (often the larger) part of the diet: fruit, nuts, berries, tubers, and so on. Even though the males

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more often than not returned empty-handed from the hunt, an infant would likelier survive if the mother could persuade one male to be her exclusive, long-term mate and provide her and the infants with high-protein food.

For this to happen, the human female became sexually attractive and available all the year round, not merely during estrus. To make the system work, the pre-human mating pattern had to evolve from one probably somewhat like those of the chimpanzee and the gorilla — sultanism tempered by promiscuity — towards the gibbon's exclusive nuclear family. As one can see, this evolutionary trend has not yet gone all the way.

Moreover, the ancient pattern of strong man-dependent woman, enforced by sexual differences in physique, had not become firmly established when it was disrupted by the Machine Age's devaluing of muscular strength. In an industrialized world, women can do a host of jobs as well as men, *if* they are willing to give up motherhood, which gobbles up the mother's time. If they are not, we have endless arguments over what is best for the kiddies.

Thus evolution explains why sexual jealousy persists, despite the efforts of some advanced thinkers to abolish it, and shows the flaw in "open marriage" schemes. A male, by chasing other males away from his female and by impregnating as many females as he can, tends to spread his genes widely through the species. Evolution selects the species in favor of males whose genes induce them to act to increase the likelihood that more offspring bearing those genes survive to reproduce. Just how the genes do this is not yet known, but we may find out sooner than we expect. We can update the saying of the victorian British writer Samuel Butler, "A hen is only an egg's way of making another egg," by saying (only half seriously): "A man is only a gene's way of making clones of itself."

The female, also, has a built-in drive to demand sexual exclusiveness from her mate, but the need in her case is for support and protection. Since she can bear no more than one infant a year, promiscuity does nothing to spread her genes through the species. If she lets her mate spread his genes around *ad libitum* without giving him a hard time, she risks his finding another female whom he likes better and abandoning his present mate. Such abandonment, especially when there are small children, is a catastrophe for her in any culture, civilized or primitive. It also reduces her children's chance of survival, or at least it did before the welfare state. There is thus a grain of truth in the jingle:

Hogamus, higamus,
Man is polygamous;
Higamus, hogamus,
Woman monogamous.

As usual with our unsteadfast species, the distinction is not clear-cut. Some men like monogamy fine; and some women, given the chance, copulate as indiscriminately as the randiest male, or as an adolescent female chimp.[12] Of course monogamy is easier if you have a world-class wife (like mine).

12. Goodall: p. 448; Robert Wright: "Why Men are Still Beasts," in *The New Republic*, Jul. 11, 1988, p. 27.

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Since the typical male is programmed not only to try to keep his mate to himself but also to spread his genes widely, while the typical female is programmed to try to stop him, we have a built-in conflict of the sexes. This struggle has furnished plots for countless stories; I don't know what composers of Italian operas would have done without it.

Like others, these sexual drives vary. Some overcome or suppress them; but suppression puts stress on the individual. As soon as the pressure is removed, the drive tends to reestablish itself, like silicone putty resuming its former shape.

Because of the variability in sex-connected drives and the contradictions arising in a transition from one sexual pattern to another, men have tried an astounding variety of sexual schemes: monogamy with or without divorce, polygyny, polyandry, *ménages à trois* and *à quatre*, hospitable wife lending, sexual communes, and even the former scheme of the Nayyar caste of India. There the woman married a tree, took a series of lovers, and gave her infants to her brother to rear. No scheme suits everybody, and some find even the oddest arrangements congenial.

The latest American contribution is the "new extended family," composed of spouses, their ex-spouses, the ex-spouses' new spouses, and so on, with the children more or less communally reared. A young girl in one such group complained loudly: "Can you imagine what it's like, having *three mothers?*" The catch is that most divorces entail hostility, and it takes only one hostile relationship to break up the group. The number of relationships goes up much faster than the number of people.[13]

Some Polynesians practiced "open marriage." A gentleman was expected to ignore his wife's adulteries, as the late Lord Mountbatten is said to have done. But the system broke down on feast days, when the men got drunk the old biological urge surfaced, and fights broke out between husbands and their wives' lovers.

So it is not surprising that, after the "sexual revolution" that began in the 1950s with the Pill, we have subsequently seen the beginnings of a sexual counter-revolution, to the outrage of those who thought that the youth revolt had guaranteed them a lifetime of unlimited free screwing on demand with anyone they liked. How far this reaction will go I cannot say. Lately Massachusetts repealed a law of 1784, ordaining that couples convicted of "lasciviously cohabiting without benefit of marriage" should stand on the gallows with ropes around their necks and receive 39 lashes each. I do not say such laws will be reenacted; but don't be surprised at anything.

Another difference between us and chimpanzees is our self-consciousness. By human standards, chimpanzees are noisy, excitable extroverts; they act on each impulse forthwith, save when they fall silent while hunting, patrolling, or sensing danger. With the evolution of *Proconsul's* descendants into man came more self-control. People found they could profit by refraining from doing or

13. If n is the number of people in a group and r the number of relationships among them, then $r = \frac{n(n-1)}{2}$

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saying what they thought if they could thereby gain some future objective. The chimp's ability to silence his natural ebullience presages this.

Perhaps self-consciousness developed with speech. The change is not complete, or there would be no crimes of passion; but it introduced hypocrisy to the world. That was not all bad, either.

Up to the dawn of speech, we may guess that the everyday lives of these pre-men resembled those of other advanced primates, especially the chimpanzee and the baboons of plains-dwelling species. Even after this advance, change went on at a glacially slow pace for hundreds of millennia. Even the invention of the carrying bag, the domestication of fire, and improvement in tools made little change in pre-men's wandering, foraging daily lives in little bands of, perhaps, fifty to a hundred members.

At some point our ancestors lost most of their hair. We can only guess why. Perhaps the loss was an adaptation to running in intense heat, since a hairless body could be better cooled by sweat than a hairy one. But then our forefathers could not leave their African Eden for colder climes until they either evolved their hair back or learned to wrap themselves in animal skins. Inventing clothes, probably during the *Homo erectus* stage, proved the quicker expedient.

The big changes in style of life came later, with the Agricultural Revolution about 10,000 years ago and the Urban Revolution about 5,000 years ago. These events stimulated an enormous increase in numbers, for which nothing in mankind's history had prepared it. Moreover, these changes came too fast for the species to adapt itself by evolutionary selection, with one exception. Cities promoted plagues. After a few thousand years, the Old World people most susceptible to certain diseases had been killed off, so that the survivors had some resistance.

Around 1500 the Europeans, having the gun, the compass, and the ocean-going ship when nobody else had this combination, set out to conquer the world as others such as the Arabs and the Mongols had tried before. Europeans moved into any piece of real estate that took their fancy and told the inhabitants, who thought they owned the place, to get lost. When the "natives" protested too vigorously, the Europeans mowed them down by superior fire power, as in 1893 fifty white South Africans with six machine guns killed 3,000 out of King Lobengula's 5,000 Ndebele warriors, charging with assagais.[14]

By 1900 the Europeans had brought nearly all the world under their sway, rationalizing their conquests with clichés like "manifest destiny" and "the white man's burden."[15] In the Americas, Australia, and Oceania their task was

14. Daniel R. Headrick: *The Tools of Empire* (1981), pp. 121f.

15. Coined respectively by the American newspaper editor John L. O'Sullivan in 1845 and Rudyard Kipling in 1899. Kipling composed the poem *The White Man's Burden* as a warning to the U.S.A. against the problems it had bought by its conquest of the Philippines, 1898-1901.

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smoothed by Old World diseases. These killed off the natives of those areas, who had not been exposed to them before, by millions. Far more Native Americans were slain by measles, smallpox, yellow fever, and other Old World ills than by the white man's bullets. The Asians and Africans, having long been exposed to these sicknesses, did not conveniently die off and in time recovered the rule of their lands.

Since men could not evolve fast enough to cope with their growth in numbers, they had to make do with cultural adaptations: large-scale government with its tyranny, bureaucracy, taxes, and corruption; cities with their crowding, conflagrations, epidemics, class distinctions, and crime. Men's brains, however, had given them not only enormous teachability but also an extraordinary adaptability. Evolution had defined male and female roles; but adaptability enables people to modify or even exchange roles—albeit not entirely without stress. After all, evolution did not design me to sit at a desk and pound out stories and articles on my old Smith-Corona, either.

Religion, liquor, and hypocrisy became the lubricants to enable men to get along in vastly greater masses than the species had evolved to cope with. We may lump secular philosophies like Stoicism, Confucianism, and Marxism in with the religions as corrective ideologies, composed to make people behave better; but such philosophies have not yet proved notably more successful at this task than the supernaturalistic religions.

As for liquor, Professor Katz of the University of Pennsylvania infers that men were first induced to settle in fixed abodes, not by the domestication of cereal grasses in Syria and Iraq, but by the discovery there that the mashed seeds of these grasses could be used to make beer. Those folk had been doing all right hunting wild sheep, goats, and antelopes and harvesting wild-grass seeds; but to make beer they had to settle down and stay put while waiting for the mash to ferment. No beer, no civilization.[16]

It has been said that we should be better off without civilization. This fantasy started with Jean Jacques Rousseau who, knowing nothing whatever of real primitive life, in 1755 proclaimed: "Nature has made men happy and good, but Society depraves him and makes him miserable."[17] Anthropologists studying the world's few remaining hunter-gatherers report that those they saw seemed a cheerful lot, who had to work fewer hours a day to survive than civilized men.

However, the anthropologist Richard Lee reports, on the !Kung, a Bushman people of southern Africa. In recent decades the !King have mostly gone from the hunter-gatherer life to farming and cattle raising. Their old easygoing communistic food sharing has given way to private property and competition, with all their woes.

Still, an aged !Kung who remembered the old days said "how wonderful

16. S. H. Katz & M. M. Voigt: "Bread and Beer," in *Expedition*, v. 28, n. 2, 1986, p. 23.
17. J. J. Rousseau: "Discourse on the Origin and the Foundations of Inequality Among Men," Chap. 2.

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their life is now with shelter and an assured supply of food, and how anxious they were when they lived as nomadic hunter-gatherers, always wondering if lions would kill them or if they would find enough food to eat."[18] Man's adaptability lets him survive an extraordinary variety of cultures, but each has its painful as well as its pleasant aspects.

Another change, to which man's adaptation is less than perfect, involves risk, pain, and suffering. As the old !Kung said, hunting-gathering life had plenty of these. Like other organisms, chimpanzees suffer injuries and illnesses, and they either get well on their own or die. An old chimpanzee may starve from being too weak to climb for fruit. Hence wild chimps, it is thought, seldom surpass twenty-five years. In the best sort of captivity, they may reach thirty or even forty-odd.

Hunter-gatherers were in a similar position, but the farming and urban revolutions have on the whole lengthened life expectancy. In the advanced countries, the last century has seen the life expectancy at birth double.

The price is that, ever since the Agricultural Revolution, more and more people have worked at routine, low-risk tasks. The lesser risk gives longer life but also brings boredom. Having long been programmed to endure danger and suffering, they become itchy in their absence, like the hair-plucking gorillas. To add spice to their lives, they go out of their way to incur risks. They gamble; they drive fast; they engage in hazardous sports; they hunt; they choose high-risk occupations like policeman, fireman, soldier, stunt man, test pilot, or professional criminal. And they march off to war like children to a party. Kipling was not altogether wrong when he wrote:

We are very slightly changed
From the semi-apes that ranged
India's prehistoric clay;
He that drew the longest bow
Ran his brother down, you know,
As we run men down today.[19]

I have used "drive" and "urge" without defining them. A century ago, those who thought a human act was caused by an inherited factor said the person acted from "instinct." Even the great Freud used "instinct" in this loose way. Now we can be a little more precise.

When a spiderling hatches, it soon begins to build a web. Depending on the species, the web may be very complex. The spiderling has never seen a web, and no parent is nigh to teach it. Nonetheless the web takes form in all its geometrical glory. "Instinct" can be rigorously used for the programming of the spiderling to build such a web. Such instincts occur throughout the animal kingdom.

In vertebrates comes a shift away from pure instinct towards learning ability. Otherwise it would be impossible to train any beast to obey commands. The animal's teachability may be small; it takes enormous time and repetition to teach an alligator a simple trick. In pri-

18. Phil Donahue: *The Human Animal* (1986), p. 68. The "!" represents a tongue click.

19. R. Kipling: *A General Summary*, St. 1.

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mates, learning ability expands; in the apes, more so; in man most of all.

With the growth of teachability, instincts shrink. In man this shrinkage has left as the only true instincts, in the narrow sense, the sucking and grasping of a baby. There are signs of such shrinkage in other manlike primates. Female chimpanzees, caught young, reared in captivity, and then bred may act as if they had no idea of what to do with their newborn infants. Like most primates, chimpanzees are imitative. In the wild they learn mothering by watching other females; but in captivity they had no role models to mimic.[20] Whereas monkeys, like most mammals, can swim, apes seem to have lost their swimming instinct. If dropped into deep water, they simply drowned.

Still, many human acts may not be rigidly controlled by an inherited program, as with the spiderling, but still be influenced by inborn factors. This brings us to the nature-nurture controversy.

In 1690 John Locke presented the human mind as a *tabula rasa*, a blank tablet, on which ideas were inscribed solely by experience. In attacking "innate principles," Locke was thinking mainly of religious and political convictions. Later thinkers broadened the idea to include all human acts. On the other hand, folk wisdom always assumed, in such sayings as "Like father, like son," that heredity significantly influenced human conduct.

The argument smoldered until in 1900 when three European biologists rediscovered Mendel's laws of heredity. Popular versions of these doctrines gave the public an exaggerated idea of the effect of heredity. These notions were combined with the Aryanist cult to create fables of "sound pioneer stock" and "good aristocratic blood." Dominant groups seized upon the idea to rationalize their dominance as due to inborn superiority.

In the 1920s and '30s a reaction set in. This was partly a correction of previous excesses and partly an emotional recoil from the pretensions of groups claiming superiority on hereditary grounds. Another factor was a reaction against the pseudo-scientific racial doctrines of the rising Nazi movement.

Still another factor was Marxism. This philosophy, as developed by Lenin, assumed an extreme environmentalism because it justified the Communist cause. The argument was that under Communism everybody, brought up on correct socialistic principles, would grow up intelligent, virtuous, and altruistic. Somehow this seems not yet to have happened.

By this argument, plus fakery, Trofim Lysenko, in the 1930s, persuaded Stalin to put him in charge of Soviet agronomy and biological research. Genetics was suppressed; at least eight geneticists were shot on trumped-up charges of, among other sins, being "spies for British imperialism." The poor Russians ended up hungrier than ever.[21]

These factors swung the climate of opinion among psychologists and other social scientists to an extreme environ-

20. Reynolds, *op. cit.*, p. 79.

21. Conway Zirkle (ed.): *Death of a Science in Russia* (1949), *passim*.

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mentalism, which still prevails. According to this view, heredity accounts for practically nothing in one's abilities. All is the result of one's environment or experience, including one's culture. If heredity has an effect, it is unfair and undemocratic, and we should pretend that it does not exist.

In this view there is no "human nature." There are only individuals, all conditioned by infinitely varying experience and not affected by inheritance. Once man attained speech and made other adaptations like fire and stone tools, the old instincts vanished utterly. Such a view remains popular with those who like to believe that people, being infinitely plastic, are also infinitely perfectible. Alas, if it were only true!

In fact, some human qualities, like eye color, are plainly the result of heredity alone. Others, such as which of the world's 3,000-odd languages a child learns, are just as plainly a matter of environment. But the sources of many other qualities are less obvious. Usually both heredity and environment combine to produce the result.

The Harvard professor Edward O. Wilson has tried to nail down the precise relationship of heredity and environment, calling his discipline sociobiology. Since people do not like to hear that their beliefs are fallacious, efforts to reestablish heredity as a factor in human behavior aroused intense hostility. Those who advanced such ideas received much abuse and hostility for their unfashionable views.

The anti-hereditarian fever crested during the great youth revolt of 1965-75, in my longeval view the most irrational, self-destructive mass movement since the Peasants' Crusade of 1095. Then, Peter the Hermit and Walter the Penniless led a mob of German peasants across Europe, massacring Jews and robbing, raping, and murdering anyone else who got in their way, to Asia Minor, where the Turks happily slaughtered the lot. (Peter managed to miss the final battle.)

During the youth revolt, hereditarians were attacked as fascists and racists, had their offices trashed and their records destroyed, and one was killed by a bomb. At the 1978 meeting of the American Association for the Advancement of Science, when Edward Wilson got up to speak, a mob of environmentalists rushed the platform and emptied a bucket of water over Wilson's head.[22]

What Wilson had proposed was a solution to a longstanding puzzle: Why do organisms try to insure the survival not only of themselves but also of their kin? Ardrey cites a case seen by a South African naturalist, Eugène Marais, with a troop of baboons. A leopard stalked the baboons, whereupon two adult male baboons stalked the leopard and sprang upon it from above. The leopard killed both, but not before one had pierced the leopard's jugular with its fangs. So all three died, the baboons defending their band.[23]

A gene-guided instinct of self-preservation is easy to grasp, but why an

22. Albert Rosenfeld: "Sociobiology Stirs a Controversy," in *Smithsonian*, Sep. 1980, pp. 73-80.
23. Robert Ardrey: *African Genesis* (1961), pp. 80f.

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instinct to save one's kin? The answer, set forth in 1964 by W. D. Hamilton and adopted by Wilson, was one of those things that look obvious *after* someone else has explained the mystery. While an organism's kin do not have the same genes it does, they have substantial fractions of identical genes: half for each offspring, other fractions for other relatives. While self-defense remains the strongest single drive, defense-of-kin comes a good second. In urging the beast to defend its kin, its genes are making sure that not only they but also their counterparts in the relatives have a better chance of survival.[24]

Since no hypothesis has ever been proved or disproved by pouring water on professors, let us see what *did* become of our forebears' instincts. Save for infants' sucking and clinging, they have dwindled to the vanishing point. It is doubtful whether a human pair who had never seen copulation or heard about it would know how. But the idea that people are infinitely plastic won't wash, either.

The old instincts linger as ghosts of their former selves. If they can no longer compel a human being to do something he has resolved not to do, they can urge and cajole him. Most of the time he finds it easier to go along with these urgings than to defy them.

For instance, mammals have a widespread tabu against mating with siblings. The mammalian brain seems to be so wired up that those with whom it shared infancy usually (but not always) fail to arouse it sexually. This has also been noted among chimpanzees.[25] Among human beings, the moral codes of virtually all societies forbid brother-sister intercourse. The tabu is not a total preventative, as a true instinct would be. Such copulations occur; in a few cases, as in the ruling families of the Ptolemaic and Inca empires, it was made official.

We may call these attenuated instinctual urges "drives." We see them at work all around: the drive to become alpha of one's group; to defend oneself and one's kin; to hunt game; to find a mate; to share one's substance with mate and offspring; to guard territorial boundaries; to be wary of strangers; and so on. Besides drives, some tendencies do not appear spontaneously but are triggered by outside stimuli, such as the common phobias about heights, snakes, and so forth.[26]

These drives are often reinforced by cultural commands and tabus, such as the incest tabu. Again, the culture may oppose the drive, as in monogamous lands the laws against polygyny oppose the male's urge to spread his genes. But such laws are seldom completely successful.

Any human action is the complex result of inborn drives, the commands of culture, and individual idiosyncrasy. Often the drives are so buried under cultural commands that the individual

24. C. V. Lumsden & E. O. Wilson: *Promethean Fire* (1983), pp. 30f; S. J. Gould: *Ever Since Darwin* (1977), p. 222.

25. Goodall, pp. 467-71.

26. As the majority of readers know, most snakes are not only harmless but also beneficial to men, by keeping down the rodent population. But primitives did not draw such fine distinctions.

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seems to have no "human nature"; he is a mere puppet dancing on cultural and environmental strings. But now and then the drives burst out, causing an individual to do crazy, self-destructive things that seem inexplicable until we consider the primeval forces driving him.

Thus the male's drive to spread his genes abroad may lead one to wreck a promising political career by reckless fornications. When an embattled group has everything to gain by unity, an ambitious one who finds his path to alphahood blocked may lead a schismatic faction, even though it ruins the prospects of the group as a whole.

So it makes no sense to say that *this* act results from heredity and *that* from environment. Both contribute in widely varying degrees, and there are too many obscure, unquantifiable factors to reduce an act to a neat equation. The most we can say that, since *Proconsul,* the effects of environment have grown stronger relative to those of heredity; but we cannot say how far this trend has gone. The professional cynic La Rochefoucauld said: "When we resist our passions, it is more on account of their weakness than our strength."[27] But one cannot measure a passion or a cultural taboo against it in dynes per square centimeter.

So what about the ape-man within us? He is there, all right—but in his time he merely did, in a crude sort of way, the same things we do. He took a mate, begat offspring, and tried to protect and support them; but he would not turn down a chance for a little adultery. He enjoyed dancing and hunting. He formed friendships and enmities. He was easily roused to hostility against other bands. He was easily taught to fear snakes, spiders, heights, dark inclosures, lightning, torrents, and strangers. If he had the right stuff, he could have a shot at becoming an alpha.

If one of us were translated back to the time before pre-men learned to talk, it would be hard to establish understanding beyond what one might have with one's dog or cat. If, however, we found ourselves among those who had made the evolutionary leap of speech, and we came to know one of these naked slope-heads well, we should find that, behind the beetling brow and receding chin, he was

Not a demon fell,
Or an archangel,
But a man very much like me![28] ■

27. F. de La Rochefoucauld: *Maxim 122.*

28. W. S. Gilbert & Sidney Grundy: *Haddon Hall,* Act two.

●Some days the name *Homo sapiens* seems the height of arrogance.

Kelvin Throop III

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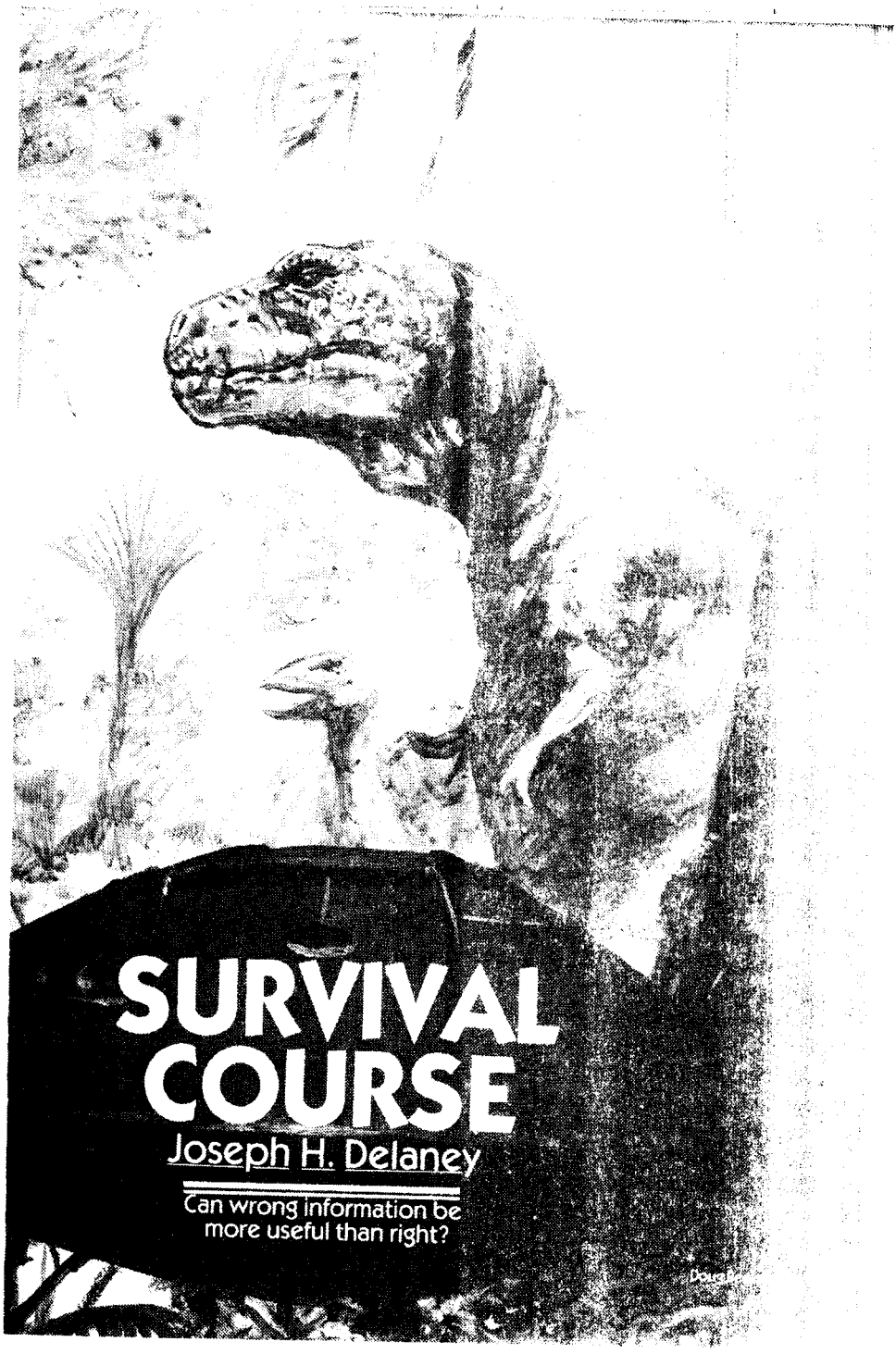

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The men who waited in somber silence inside the heavily armored timepad were, physically, vastly different from one another. Cletus Running Wolf, descendent of ghost dancers, was lank, loose-boned and copper-skinned. Clinton Mineau, great-grandson of a buffalo hunter, was small and dark and quick.

Temperamentally, they might have been twins.

Cletus sat in the command chair, a misnomer, since their only internal control was an override for the timer, to shorten or extend their stay.

"You don't need to maneuver," Dooley's parting words echoed in Wolf's memory. J. B. Dooley was director of the Institute for Temporal Studies, an autocrat whose logic had sounded convincing—then. "We've got an accurate computer model and we'll put you down at the mission's optimum location. Also, this model has an escape system. If the pad's pilot sensors detect anything but level, dry land the program aborts."

Wolf had found that comforting—for a few seconds, but Dooley spoiled things by adding, "I know you'll do a good job. Come back alive and in one piece."

Momentarily he dwelt on his unlikely presence in a spot like this, on a junket through history, into the vastness of time past. He quickly shook his worries off. He was already committed to endure the effects of a truly stupendous burst of force, of the expenditure of energies previously unknown outside the hearts of stars. Though punching through required mind-boggling force, onboard systems easily supplied the minuscule energy needed to maintain stasis. To return, simply cutting the power squirted a pod back to the present like a man spits out a watermelon seed. Never before had *Homo sapiens* cooperated on such a scale, but he had to this time, the cost would have broken any one nation and the need was urgent.

Wolf's greatest dread now was that awful nauseating disorientation time travel caused. This sojourn to the early tertiary was the longest ever attempted, and experience suggested the severity of the physical effects would be proportionate.

These seized him, and they were. When his own agony subsided Wolf gazed with envy at Mineau, whose psychological safety valve had taken consciousness away. Mineau would have no unpleasant recollection.

The pod then shuddered, having encountered uneven ground, perhaps boulders, or forest. Wolf feared the mission might terminate, but then he heard the hiss of the huge hydraulic landing jacks when they damped motion and leveled a pod.

Wolf did not rise when it stopped, and cheat Clint of this moment. They should share this. It belonged to neither, but was theirs in common.

He waited patiently, contemplating both the future and the past, both essentially immutable. Man might travel back as far as his energy took him, but the future was absolutely barred. Causality ruled supreme.

In the past he could react within limits, which while usually fairly broad, were occasionally absolutely unbendable. If the actor or his objective did not matter to the gross course of reality, things were essentially normal. But no actor with a place in the immutable,

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foregone future could be harmed while in the past, nor harm a counterpart he found there, which raised the specter of a super-theropod shedding rocket grenades and cyanide bullets like raindrops and gobbling the men up.

That wasn't very likely for dinosaurs. There was greater risk from prosaic creatures like venomous snakes, ancestral lines that might survive into modern times.

Hence the choice of this location, on the edge of a subducting mass the model predicted would never again rise above the sea. They hoped what happened here would have no causal consequences, but nobody knew for sure, anymore than they knew when the next cosmic missile would strike Earth.

Nobody doubted another would. Object Isis, a flying mountain two kilometers across, just had, portending a dismal future. Isis arrived on just the right vector to lightly graze Antarctica before plunging away.

Yet it had devastated Earth, whose atmosphere rang like a bell from the shock. Its plasma cloud carried an enormous current all around the planet, creating an electromagnetic pulse of such formidable magnitude that four-fifths of the world's power and over 90 percent of its electronic communication were down for weeks. The magnetic field reversed polarity, and world-wide weather was upset. Millions of people died, just from a *glancing* blow.

Isis cowed men into cooperation. They wondered if the deathstar could be real, if Earth could survive a square, solid hit, if *Homo sapiens* faced the same end as dinosaurs. They had to know how *some* life had survived that. Time travel was the way.

Cletus and Clint were superbly qualified investigators. Both were ex-members of the U.S. Special Forces. Cletus had since become a brilliantly innovative peleo-biologist, Clint a leading astrophysicist. Both had proven the ability to learn and adapt. Both had worked hard honing their weapons skills to sharpness, absorbing as much necessary knowledge from allied disciplines as they could.

Wolf's musings ended when Clint stirred. If the past was any guide he would next rise, awake but innocent, full of curiousity and questions.

And he did. "We're here? What's it like outside, have you looked?"

"No, I felt a little strange," Wolf lied, "so I waited. But it seems quiet enough. Let's go see it."

Rising, he peeled back the iris of toolsteel petals from the top blister and mounted the three tiered mini staircase to poke his head above the pod.

"It looks like home," Cletus exclaimed through clenched teeth, "like we never left. Uh—except for the plants, of course. They don't belong; too many cycads, not enough trees. And look at that bugger." He pointed out a mosquito at least an inch and a half long. "I hope I'm somewhere else when she wants her blood meal."

"It's a little disappointing, Clete, I don't see any dinosaurs. Maybe we got here too late after all."

"Uh-uh. You just don't know how to see them. They're here, but camouflaged, like tigers and leopards and zebras in our time. Look over there—now

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he's a mean one." He pointed to a clump of low grasses.

With these clues Clint eventually identified a spotted hide surrounding a basketlike array of fangs, and limbs tipped with sickle-like talons. "I see him. What is he?"

"A dromaeosaur, Deinonychus, probably, or maybe Stenonychosaurus. We assume it's nocturnal because of those great big eyes. We'll have to be very careful outside. It's mean, and fast, and for a dinosaur, smart. We must have interrupted its nap."

"Well," Mineau responded in a sigh, "at least there's nothing big in the area."

"Yet, Partner—yet. How about we get this pod dug in so we can start the mission, huh?"

The pod was their only way home and their most secure refuge in this hostile era. They left its razor wire barricades liberally studded with anti-tank mines and trip-wired fragmentation grenades, lest some big clunky monster otherwise descend on it and stomp it flat.

Then they embarked in the skimmer, floating at treetop level, to establish a base camp atop a mesa. One of many eroded, broken-down cores of ancient mountains in the low range their model showed as separating the coastal highland from the tropical basin on its windward side.

They overflew a herd of grazers, mostly three pronged, heavy neckrilled ceratopsians, but interspersed with hadrosaurs, the late-cretaceous early-tertiary equivalents of wildebeests and zebras.

Hovering, they taped the scene. The beasts, no doubt equating the skimmer and its shadow with pterosaurs, displayed no fear.

Cletus was fascinated, far more so than Clint, who lacked the expertise necessary to fully appreciate what he saw, but much disturbed him about the scene.

"It's a dinky herd, Clint. This meadow should be more heavily grazed, and there should be some large predators around." His complaint died out in a sigh. He felt cheated, having always pictured the grazers constantly harried by allosaurus and its ilk, or perhaps even by the king himself, tyrannosaurus. Perhaps, he thought, I simply demand too much.

They reached the mesa, spiraled it, examined the cliff faces for possible predator invasion routes, and found nothing but a few very steep ravines and fragile looking vines. Except for swallow-like birds who plastered mud nests all over the lee face, there seemed to be no permanent residents.

Halfway up they found a dark cavern whose entrance was strewn with droppings. The powerful smell did not encourage them to tarry. Because it lacked land approaches Cletus suggested it was a bad weather haven for pterosaurs, now presumably at sea.

When at last the skimmer rested atop the mesa they found signs the wind sometimes blew very hard. Many rocks had a high, almost jewelry-quality polish. "I'm not sure I like this," Clint muttered. "Nothing will eat us *up here*, but if we lose the skimmer it's a long walk home, assuming we could get down."

"Maybe there won't be any storms

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while we're here," Wolf muttered, squinting from windborne grit. "It's like a sandblast now, in calm weather. Uh—you did pack some anchors?"

"Yep. I figured we'd need them. I brought nitrostarch too, and detonators, and some of that new quicksetting plastic. It'll be like old times, Clete, it'll be fun."

But it wasn't, it was work. And blasting released yet more grit, all of it uncommonly sharp.

They anchored the skimmer, erected their tent in its lee, then attended to creature comforts—like food, but finished too late to start patrolling. Yet the midwinter darkness was not wasted. Clint filled it with mutterings and magic over his instruments and star charts, and this time Cletus was the spectator.

Clint quickly established season, position, and length of the day, which was almost three hours shorter than the modern one. In this season and latitude daylight was shorter still, so they began to wonder how cold it might get. Atop this 1,500 foot crag it would certainly be worse than on the plain.

Wolf wondered how the smaller animals stood that. The ceratopsians, like modern elephants, were protected by size. The five meter long adults should have no difficulty, but their young, like the smaller predators, would lose heat rapidly and most had no visible external insulation. He was thankful for his. Snug inside his mummy bag, Cletus dropped off to dreamless sleep.

Morning revealed that fur indeed existed on the Earth of 67.5 million B.C., or thereabouts, since they hadn't pinned the date down any finer. They saw the first mouse-sized mammal.

It wasn't a mouse, of course, or anything like a mouse. It was almost certainly a monotreme, since fossil evidence showed even marsupial forms to be rare in the early tertiary. But it had the habits of a mouse and raided their freeze-dried food, gnawing through packages in typical mousely fashion.

They switched to metal storage containers, ate from what the raider left and made plans to scout inland.

"It's weird, Clint. Nature isn't sticking to the game plan. There just aren't enough animals, particularly big ones and particularly theropods. This would be statistically improbable unless we really did arrive too late. But if that's the case, how did it happen? You said your instruments show nothing out of the ordinary?"

"Nothing outside normal limits, Clete, nothing suggestive of catastrophe. Atmospheric constituents are grossly normal. The usual climatic culprits, carbon dioxide and methane, are well below modern levels. There's no high altitude dust cloud indicative of recent volcanic eruption, and the mean planetary temperature is square on the money with the model's forecast."

"What about a nearby super-nova. That's been suggested as a—"

"The signs are all wrong, not enough stratospheric water vapor, and it's way too warm. I can't rule it out completely but at best it would be merely contributory. Hey, *what* is that?" Clint was squinting at the eastern horizon where a veritable cloud of black dots circled lazily over the savannah.

"Pterosaurs, specifically, pterodon. No shortage of them, obviously, but

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supposedly, they're fish eaters. I wonder why they're so far inland. Let's get a closer look."

Flying into the glare of the rising sun at full speed, things on the ground were a blur. Clint could have compensated by gaining altitude, but he didn't want to scare the creatures off.

Presently, they got near enough to see that the attraction was great gobs of free meat scattered around among the groves.

"Dead ankylosaurs, Clint, all headless, like something bit them off. These pterodon are here to scavenge but obviously they're wary of something."

"They don't look like they'd be very comfortable on the ground."

"They're not. They're living hang gliders, only even lighter and more fragile, so light they can rise on the breeze. They have to, they lack the muscles to flap those enormous wings, or good enough legs to take off on the run."

"But what killed the ankylosaurs?"

"I have no idea. Hover over one and I'll go down for a look."

Cletus descended by rope while the skimmer hung overhead to guard him.

"Sliced cleanly," he yelled up, "cauterized, so there's been no bleeding. No animal did this. Somebody else is here and carried off the heads."

"Who?"

"Maybe people farther down the time line, that's the only plausible explanation. Clint, I just had a horrible thought—bring it down, I'm through here—what if *we* failed?"

"And Dooley sent another team?"

"No. Us again. What if we went back a few years later and—"

"Uh-uh, causality would have blocked us out, we never would have seen this, so it isn't us."

"Who, then?"

"I don't know—turn on the radio."

"What?" Cletus needed a moment, but he quickly readjusted to modern thinking. Somebody might be trying to communicate and they weren't listening. He flipped the switch and set the scanner to "seek." They heard only static, and speculated the others had passed out of range.

Their skimmer was solar powered. In the ample sunshine they hovered leisurely below the pterosaurs. Presently several of the bolder creatures settled on distant carcasses. Watching them through glasses, they gained new respect for those immense beaks.

But this scenerio was of brief duration. Suddenly shrieks of alarm erupted, and those below extended great wings, set the "elevators" joined to their long thumb bones, faced into the wind and rose.

"What do you suppose got into them?"

"Maybe they're just naturally timid, Clete. Creatures that fragile would have pretty strong instincts to avoid trouble."

"There doesn't seem to be anything coming. Of course, from way up there they can see lots farther, and they probably have fantastic eyesight. . . . "

"Let's get ourselves some altitude and take a look. Give me control."

The idea sounded sensible. Mineau nodded and yielded the stick.

Wolf yanked this back, twisting its grip, which controlled fan-blade pitch. The skimmer leapt skyward, scattering the flock, they fled in all directions ex-

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cept east, a most curious fact which both men quickly noted.

Mineau studied the horizon with his glasses, then sucked in his breath with a low whistle. "Fantastic eyesight is right! Even with glasses I almost missed them! Look!"

Wolf took the glasses and studied the area to which Clint was pointing.

Hidden in the glare of the morning sun, five slowly moving, six-legged creatures crawled across the bush. He matched Mineau's whistle in enthusiasm if not in volume. He watched so long that Mineau poked him impatiently to get his glasses back.

Cletus returned them, and snatched up his own. "They're huge—they must be bigger than any dinosaur that ever lived—but they can't be dinosaurs themselves, too many legs."

"Insects?"

"Hardly."

"Oh!"

"Sorry. I didn't mean to sound sarcastic. No, insects bigger than a few inches are impossible. Exoskeletal muscle arrangement is too inefficient. Insect nervous systems are too klunky and their breathing apparatus simply can't oxygenate such big volumes. These would have to be an entirely new evolutionary line operating with completely different systems, and for any that ever existed there would surely be fossil evidence. There isn't."

"I note one problem with your theory, Clete. They're out there, bigger'n sin, and seem to be headed our way."

"I do find that somewhat embarrassing. Shall we move in?"

At Clint's nod Wolf took a bearing and fed a new course into the plotter, which was already programmed to map the terrain they traversed. "Now," he grunted, "we drop to the deck and I'll use my instinctive Indian skills to sneak up on them."

Clint wasn't much amused but he appreciated Wolf's thoughtfulness in making an attempt at humor. Sitting in the right seat, hands on the weapons board, his every nerve was poised to strike. Besides heavy aerial machine guns loaded with toxic slugs, their skimmer carried, fore and aft, batteries of anti-tank missiles, on the rationale that what would stop a tank would kill a theropod.

For a quarter of an hour they crept along at treetop level, eventually reaching a a copse of trees across a clearing from the nearest of the creatures.

"Machines!" Clint's voice, though strained, was weak and whispery, as though that mattered. Their quarry would never hear them over their own racket.

"They look like Imperial Walkers."

"Huh?"

"Don't you watch the old movies? The Star Wars classics?"

"N-now and then," Mineau admitted abashedly.

"The Imperial Walkers had four legs, not six. They were war machines. Maybe these are, too."

"Who would be fighting on ancient Earth?"

"Maybe near space is part of a big war zone. Maybe nearby stars are fighting one another, with Earth like New Guinea was in World War II, strategic territory."

"Why don't we hear anything on the radio, then? Why no aircraft? Where's the wrecked equipment?"

"Maybe the show hasn't started.

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Maybe the other side doesn't know they're here."

"What if the *war* killed the dinosaurs?"

"I suppose it's possible, Clint, but a conflict that widespread that left no signs? I don't know. Still, ankylosaurs would make convenient practice targets."

"A lot can happen in 67 million years, Clete. This will all be sea floor in another 5 million years. Nuclear winter's—"

"Another possibility, I'd concede, but I'd expect more sophistication from starfaring belligerants. There are other, better ways to create those world-wide climactic changes the popular scenerios require—like redirecting meteoroids. That'd be the easiest way to knock off this garrison."

"Hm. Yes. No deathstar necessary. That'd be a relief—except—except fossil records show regular mass extinctions; one big one about every 26 million years."

"Back to deathstar?"

" 'Fraid so, Clint, or an awful long war." He scanned the retreating machines as he said that, and a puzzled look then washed over his face. "You know, those didn't look much like Lucas's machines. His bristled with weapons. These don't."

"Or humans are too backward to recognize them."

"Maybe that, too. *My* ancestors learned about guns the hard way."

"Well, are we going to follow?"

"Yeh, sure, Bwana, at a discreet distance. Clint, why do I have the feeling they're all headed straight for the dead ankylosaurs?"

"Because that's what the spirits tell you, Chief," Mineau pointed at the plotter's VDT. "Maybe they're hungry."

They inched along, pacing the walking machines, whose speed varied little, whatever the terrain. They were tall enough to span the average grove and heavy enough to flatten trees they couldn't step over.

Excitement degraded into boredom, broken only by occasional cautious slaps at insects until the humans encountered the first of the big theropods, a gorgosaurous bristling teeth and waddling along like a big chicken.

"He's snow white!" Clint observed, punctuating the remark with a whistle.

"He needs to be. If he was dark he'd soak up too much heat, and camouflage only helps stealthy hunters. He probably lives mostly on carrion and hunts seldomly."

"He's moving right along, Clete."

"Comparatively speaking, yes, he is, following his nose upwind to the goodies."

Alert now, Clint swept nearby clearings and sighted more large meat-eaters. "It's going to get crowded, Clete. I wonder why they're all coming now?"

"I'd guess the ankylosaurs were killed yesterday, probably late in the day, and it takes a while for meat to ripen in the sun—"

"What's wrong?"

"N-nothing. Just thinking, that's all."

"About what?"

"I haven't got it all worked out yet, Clint."

"Can I help?"

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"Maybe later. Get all the pictures you can, Clint?

"S-sure," Clint answered. He began poking the video camera around half-heartedly. It smacked of busy-work but he knew Cletus well enough to realize that prying was useless. Of course, once Clete had it worked out the hard part would be shutting him up.

The skimmer hovered within a copse of trees, safe from passing carnivores, of which there were now many, though few were large. They had seen only one tyrannosaurus, and it was immature. The deadly dromaeosaurs predominated, and could flit fearlessly among their bigger brethren because they were so agile.

The carrion also attracted great flocks of predatory birds, some indistinguishable from modern buzzards, and monitor type lizards with beadwork bodies and flicking tongues prowled about, dodging the big theropods and hissing at the dromaeosaurs. They were fearless too, either because of their basic stupidity or because such an abundance of dead meat made killing them too much trouble.

The men's attention were on the huge walking machines, now spread motionless in a great circle around the carrion. The beasts treated these as they perceived them, as objects.

Clint checked his watch, now calibrated to local time. "It's almost noon," he said ominously.

Wolf's return glance acknowledged. He knew they weren't charging under the trees, and that their coils were draining.

"Something better happen pretty soon," Mineau sighed. "If we don't rebuild the reserve we'll have to make base camp long before dark, otherwise we won't make it at all."

"Let's hang around a little longer, Clint. Maybe everything within range will have arrived."

Mineau nodded, but he was still nervous.

He worried needlessly. Moments later the machines stirred, though movement was vertical. They crouched, dropping down on jointed legs, which folded surprisingly flat.

Then, great hulking doorways opened and long ramps flicked out. Tiny, bubble-topped tracked vehicles rolled out and sped away. The men counted fast but never arrived at an agreed total. The things were everywhere, and moved at blinding speed.

Finally, the two astonished humans closed gaping mouths and simply stared.

Cletus spoke first. "I think I know the answer, Clint."

"Yeh?"

But Cletus said nothing more for a while. He made Mineau endure an agony of silence, until the animals distracted them again.

The first arrivals, in wild flight, were the little ones, the ones with long legs who ran on tiptoe at speeds rivaling modern cheetahs and ostriches. Some took refuge in the grove where the skimmer hovered. Some made alarmingly successful efforts to climb trees and for a brief moment, before it fell off, Clint found himself eyeball to eyeball with one of Cletus's gutrippers. "What happens when the big ones get here?" he moaned.

"They won't make it," Cletus re-

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plied grimly. "I'd bet none of them are still alive. I'd like to confirm that by moving to the other side of the grove."

"Is it safe?"

"I-I think so. We'll be out of sight of the big machine, and I think those in the little ones are too busy to notice us."

"Go ahead." Mineau threw the bolts back on his twin .50's and unlocked the mount. "I'm ready."

The skimmer threaded through the trees until opposite the old site. Here, the view was less obstructed, though none of the big machines were in it.

They were in time to see the king fall. Tyrannosaurus evidently had been saved for last because, though a juvenile, it was still the biggest. It had continued to gobble greedily while others died, and even when ringed by four of the little vehicles seemed unaware of what was happening.

A biped shaped vaguely like a man but far taller, far heavier and strangely articulated emerged from one of the crawlers and stood some 50 meters behind the king. It walked like its joints hurt, slowly, deliberately, with solemn, single purpose, brandishing a fragile looking device they presumed was a weapon. When it had halved the distance, it bent to pick up a rock which it flung with smooth power against the back of the dinosaur's head.

The beast paused briefly, lowered its head and took another bite.

Its antagonist got another rock, approached even closer and threw even harder.

This hit the king's bony ear opening, evidently a tender site. It roared angrily, swinging its massive tail at the stranger. He adroitly side-stepped, and hurled another rock.

Then Rex acknowledged the challenge, forgot his belly and turned to vengeance, shaking its great head so violently that it slopped a five gallon stream of bloody saliva across the front of the attacker's clean white tegument. He pawed like an enraged bull, talons raking up great gouts of dirt and dried grass, sending clouds of dust downwind after the saliva.

The biped raised a now-muddy weapon in a now-muddy hand and waited. At Rex's first step he fired its bolt point-blank into the creature's chest.

The smell of burnt meat and boiled blood rode the wind to the men's nostrils. Neither had ever conceived a hand-held energy weapon of such awesome power. They knew what they watched was alien, and presupposed a massively technologically superior culture. Neither of them, armed as formidably as they were, would have dared approach tyrannosaurus that closely.

Rex toppled, its heart literally cooked while it still beat, its relatively tiny brain, requiring as it must, whole gallons of blood every single second, so immediately starved for oxygen that it could not function, not even by instinctive reaction, to continue the attack.

The next development was more astounding still. The victor adjusted his weapon and fired again. With a beam much thinner but just as energetic, he lopped Rex's four foot long head off.

The humans gasped. They dared not move now that the alien was less prone to distraction. They feared the faint sounds of the skimmer's idling fans would give them away.

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But there was more distraction. The walker rose and approached. Within moments it stood astraddle Rex's corpse, guarding this and Rex's conqueror from the lesser carnivores with which the area still teemed.

"OK, talk, Cletus." Mineau now supposed Wolf had reduced his idea to a working hypothesis, since he had been so uncharacteristically silent for so long.

"I think the head's a trophy. Perhaps they will also take its hide, but they will leave the meat to rot." He turned to the gaping Mineau. "Hunters, Clint. Not soldiers—big game hunters; slaughtering the dinosaurs for 'sport,' like the white man slaughtered the buffalo. Look out there. What do you see?"

Clint raised his glasses and saw exactly what he expected to see, now that Wolf had explained it, the other walkers, the vehicles of this "safari," lowering grapnels and hauling trophies up into gaping cargo holds. "The ankylosaurs are bait, to pull carnivores out of that jungle down in the valley?"

"It's probably too dangerous to hunt on foot down there, Clint, even with beam weapons. They'd have to hunt like the Maharajahs hunted tigers, but on walkers instead of elephants—hey, they seem to be leaving. I think we should get out, too."

"Agreed. If anyone took a shot at us this skimmer would be no protection."

The whiskey wasn't on the supply manifest for the simple reason they weren't supposed to have it. At roughly $400,000.00 per ounce it was expensive booze but it was far more useful than the crash locator beacon torn out to make room for it.

"I'm dry." Wolf raised his glass, which glistened in the candlelight.

"My ancestors would spin in their graves if they saw me giving whiskey to a redskin," Mineau chided, as he poured.

"So will mine, when you get up tomorrow morning with your hair," came Wolf's stinging riposte.

"Let's not tell them, Pal."

"S'deal." There followed a loud slurp.

"No, no, I mean it."

"I don' unnerstan."

"Then shut up and drink; get paralyzed and quit worrying."

"What's gotten into you?"

"We'll talk about it in the morning, all right?"

"Sure."

But by then neither felt much like talking. Not quite 100 percent hung over, they had still come close, and overnight mother nature played a mean trick, she planned to run them off their perch. Out at sea stormclouds gathered and the wind rose ever higher.

They took it philosophically, considering that the scarcity of large predators in the vicinity of the pod made staying there safer than they had supposed.

But, they didn't get to leave without a fight. Even as they broke camp, while they struck the tent the pterosaurs began arriving, and these went first not to the cavern, as sensible creatures should, but landed lightly on the mesa top or circled round the tent.

At first the men didn't know what to make of it, but as the circle began closing around them with more and more of the fragile monsters dropping in, they

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knew a territorial challenge was shaping up.

The flapping fabric didn't look threatening to humans, but its shape and movement irritated the pterosaurs, who crept ever closer on their clumsy little feet, and occasionally flopped down prone to scoot like penguins.

Some of these monsters had wingspans approaching fifty feet, and great double pointed heads resting atop necks upwards of ten feet long, on which they jabbed their beaks out like spears. Mineau snatched an automatic rifle and fired a short burst, scaring most away.

"Look at our tent." Clete pointed to the shredded cloth. "We'd better get out of here."

Wolf's immediate response was to frantically throw equipment and supplies into the skimmer's small cargo hold, and keep his own rifle within reach. "The tent's ruined, Clint. Let's leave it."

As the sound of his words died a giant shadow fell on them. They looked up to find an equally gigantic pterodon hovering over the tent, balancing itself on the wind with fine movements of its elevator digits. Again and again the beak stabbed out, striking so sharply that the joints on the tent frame began to let go. A section of this fell across the cockpit of the skimmer, which the men were trying to enter, and then the skimmer was attacked.

Theirs was rugged, a heavy-duty military model, still it could not withstand that beak indefinitely. Already, stuffing erupted from the pilot's chair.

"We have to stop that," Wolf screamed. He raised his AR and fired a burst into its shaggy-haired body. The heavy caliber, hollow pointed, high velocity bullets would easily have knocked an elephant right off its feet, but the creature ignored them, jarred just a little by the impact as the slugs bounced off it. It pressed its attack.

"We're in trouble, Cletus."

"I-I know. My fondest nightmare, come true. We can't let it destroy our transportation," he muttered as he butt-stroked the pterosaur's head. Strangely, this affected it more than shooting it had, and it momentarily retreated.

But it counter-attacked, and an instant later its murderous beak bounced off Clint's ribcage.

"Well, what do you know?" Wolf growled with amazement. "Now it's Supermineau versus Superpterodon. You're both crucial to history."

Mineau had already reached the same conclusion. He knew Wolf and the skimmer probably weren't, so he must protect them. He seized the creature's head and pinned it, discovering once the beak was closed he could easily hold it shut, and being vastly heavier and stronger he now controlled its head movements. And motion was why the beak was dangerous. Speed translated into penetration.

But this pterodon wouldn't give up, as an ordinary one necessarily would have. Every fragile bone in an ordinary pterodon's body would have been pulverized by now, with all the thrashing.

"Get the skimmer ready, Clete. Back off, so when I let go it'll have to chase it to attack."

"Right!" Wolf hacked through the anchor lines with a machete, bounded inside and fired up. He hovered briefly just off the surface, then slid sideways

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toward the pterosaurs who watched from the rim.

As Mineau surmised, the pterosaur followed to attack, but his prediction failed from then on. The creature's leathery wings spread and it rose, somehow maneuvering right over to the skimmer in a split second.

Wolf slammed the cowling just in time to avoid a murderous peck and its beak glanced off the heavy plastic like it was armor plate.

"I'll raise it. Grab the anchor ropes and ride down outside."

Mineau nodded acknowledgement. Instantly the skimmer floated just over his head while the pterodon continued its attack. He made a noose in one rope and slipped a foot in. "Go!" he yelled.

Unbalanced, the skimmer wobbled erattically but the creature only followed halfway down, breaking off its attack and entering the cavern as though nothing out of the ordinary had happened.

Once Clint was back in the cockpit they relaxed. "Well," Wolf said, relieved, "Now we know who rates."

"You should take the test yourself sometime, Cletus. It'd be a revelation."

"That's the part that scares me. But you will admit, you've proven the causality theory. By the way, it also proves this is our Earth. I had my doubts for a while."

"It'll be a curse," Mineau replied grimly. "I'll never be sure how far I can trust it. I wonder why that big turkey's important."

"Probably some day we'll find his fossilized bones. Considering their ability to migrate, flying creatures aren't much bothered by tectonic calamities. He might even be one of those from the Big Bend."

"The what?"

"It's in West Texas. Comparable giant pterodon skeletons were found there in the National Park in 1975."

"Texas? Yeh, it'd figure."

"Cletus, can you come up here?"

"Why?"

"Company's coming."

Wolf was cooking breakfast, while Clint was on lookout in the dome. He lifted the pot off the catalytic stove and made the trip in less than six seconds.

"What do you make of that?"

"Looks almost like a skimmer."

"Bigger, Wolf, and very well armed, if I'm any judge. Does the light bar on top suggest anything?"

"Cops? A squad car?"

Clint nodded.

"Of all the infernal gall! On our planet! What do these aliens think they're—"

"I'd guess they probably think they're going to arrest us, if I was in a guessing mood."

"We can't risk contact. We have to leave."

"We can't get out that fast, Clete. Recycling the timer takes twenty minutes. They'd burn our doors off long before that. And then, of course, the mission's all over."

"Dooley wants us both back in one piece—one piece apiece, that is."

"He wants to know what killed the dinosaurs, too."

"Our timing might be way off—you said that yourself."

Clint ignored him. "They're coming

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in. Tell you what, why don't you start reprogramming while I hold the door?''

Cletus needed no urging. ''Keep me posted, Clint.''

''OK. Well, let's see—ooh! That one's double ugly; these are definitely not the species we saw yesterday. One's a short fat guy with coiled tentacles for limbs and a can of worms for a mustache. The other one's like a big grasshopper—four walking legs, two manipulators, but he's obviously endoskeletal. They're out of the car, coming slowly this way. The grasshopper guy's got a microphone, like he's talking to somebody. Uh, they're both wearing what looks like the kind of beam weapon we saw yesterday. How you doing?''

''Got the main sequence going, set to pop at the end of the program. I hope we're still in here then.''

''We will be. Causality, remember, I'm historically important.''

''Y-yeh. What about me?''

''I won't go without you, pal, I promise. Hey, what's that?'' Mineau switched to a small peephole in the master hatch. ''They're inside the perimeter. One of them must have rapped on the hatch.''

''Don't open it.''

''If we don't they might shoot their way in.''

''Uh, yeh. Well, we don't want that. I'll be down to help you in a minute. I'll bring you a .45.''

''Where are you gonna get one? They didn't give us—''

''The whiskey didn't quite make up the weight—we had a couple pounds to spare so I—''

''Bless you, my son. Gimme.''

Wolf joined Mineau and handed him an automatic already cocked.

Mineau stuffed it under the back of his shirt. ''Whenever you're ready.''

''No, no, Clint, you've got it all wrong. You see, we're the bad guys, so it's OK for us to shoot first.''

''Dontcha' want to ask them what we did?''

''Sure, but . . . ''

''Or maybe they're selling tickets . . .''

''To a ball? OK, go ahead, Supermouth, live dangerously, you're covered.''

When Clint slid the hatch back the smell that entered was overpowering. It was like rotten garlic mixed with eau de skunk. The tentacled cop must have been used to that reaction. He retreated slightly.

The other raised his ''microphone'' and spoke, though the sounds made no sense to the humans, who answered to that effect. This didn't seem to bother the cop. He jabbered on.

They tried sign augmented speech, briefly, awed by the alien's magnificent patience. Somehow, the display of restraint by police was unnerving.

The grasshopper cop's next words were intelligible, after a fashion. Cletus easily picked out an English word — ''license.''

He stared at Mineau. ''Did you hear that.''

'' 'License.' He wants to see our license?''

'' . . . not in our . . . base.''

''That's some kind of electronic translator—no, wait, it has to be psionic, to work that good, that fast. That's why he kept talking. It's probably tied into a computer somewhere. The more we talk the bigger the vocabulary.''

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"Now how would you know that, Clete?"

"I toldja, I study the classics. There can't possibly be any other explanation."

"We have no record of you or your vehicle at the portal. What is your world of origin?" The grasshopper cop extended his mike for their reply, while the stinky one nervously tentacled the butt of his weapon.

"Uh, we're Earthians," Wolf replied brazenly, wondering what a portal was.

The grasshopper cop "listened," then made an adjustment. Strange sounds erupted from what looked like earphones perched just above his shoulder bones. At length he spoke again. "No 'Earthian' appears in departmental records."

"Department?" Cletus continued the charade. "What department?"

"Game Conservation."

"Oh. We didn't know who you were."

Clint was taking gas. He "heard" everything, too, of course, and since he lacked Wolf's audacity might otherwise have been willing to let Wolf do the talking. But because he didn't like the direction the conversation was headed he intervened. "Look," he interrupted, "we're scientists, not hunters. Why should we need a license?"

"Why, indeed?" The grasshopper cop replied, "if that is true."

Wolf took it again. "Sure it's true. Look around. See any trophies? See any weapons? Come inside if you like. We have nothing to hide."

To his disgust both aliens immediately accepted, and in close quarters the tentacled one stank even worse. But after poking into lockers and asking a few questions, they seemed satisfied.

"You understand," the grasshopper cop explained, "we're only doing our job?"

"Of course. And we're trying to do ours—we're on the same side as you game wardens. We want to protect the dinosaurs, too. That's why we study them."

"They are magnificent," the alien replied, adding the equivalent of a sigh. "But we're losing. We only just got legislation to restrict hunting but some of these entertainment companies had long term contracts, so the legislature excepted them. With so many different races involved we had to give everybody equal treatment. We figure long before the contracts expire the big species will all be extinct.

"And still there will be hunters demanding heads, even those from the smaller species. Hunting's already being justified by claiming the herds need artificial culling because predation no longer controls them. You must have noticed how thin the population is in this region."

"We noticed," Wolf replied. "Is it that way everywhere?"

"Worse, in most places. We've tried hatcheries and relocating some varieties where local extinctions occurred but its hard to maintain large enough breeding populations.

"Worse, the 'hairy' population is exploding. Big forms of 'hairys' will surely evolve. These already raid egg clutches and compete for food. Not even the marine types are safe, since many must lay eggs on dry land. The 'hairys' are too small and too numerous to pos-

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sibly exterminate and they make a bad situation worse."

Wolf nodded, a gesture the wardens seemed to understand. They were like their counterparts everywhere, concerned, conscientious, and well aware that their job was a thankless one.

"I'll have to cite you for trespassing," the grasshopper alien said, after a long silence seemed to signal the conversation was over. "It's just a formality. Clear it through the Confederation Commissioner on your home planet when you get back. Meanwhile, here's a temporary permit to carry on your research."

He paused, then added. "You can't take eggs. You can't hunt endangered forms, even for scientific specimens. If you kill one you better be able to prove it was self-defense—I suggest you remove anything lethal from your perimeter defenses."

"That doesn't seem quite fair with the hunters—"

"I agree, but I don't make the rules. This is an undeveloped planet, with nobody to speak for it. The federal government thinks racial peace is more important than protecting backwater worlds whose animals are the only exploitable resource."

"It's a dirty shame," Wolf replied.

"It is indeed, but that's the way things are. If a portal hadn't chanced to open here when it did, greedy people wouldn't have found this world and its creatures might have evolved into something. You must have noticed, some already have pre-adaptions that could have led to sapience?"

Again, Wolf nodded.

"We'll try to save those, at least. We still have hope. Maybe when hunting gets unprofitable these barbarians will tear out the portal terminals and lodges and nature can finish its job. It's hard to believe that at one time these gameherds stretched from horizon to horizon."

"I've heard such stories, too," Wolf replied soberly.

"Well," the grasshopper cop replied, "It's been refreshing. I don't meet many kindred souls. Good luck in your research." He shambled off.

Wolf stopped him with a shout. "How do we identify the endangered species?"

"Oh, sorry," the grasshopper alien replied, "just assume that any big animal you see, especially carnivores, is in peril—but, I'll give you a catalog, with pictures, in case you can't read 'Standard.' Be right back." He started off again.

"Look at this!" The book Wolf held was thick, and its pages thin. It was crammed with pictures and script. "We'll probably never be able to read this, but the pictures will be invaluable."

"Burn it, Clete."

"What?"

"Burn it."

"Are you nuts? This is a more complete catalog of tertiary life than we have on 21st century fauna. It'd be criminal to let anything happen to this."

"There's no choice, Clete. Do you know what happens if we go back and tell the truth?"

Wolf stared wide-eyed at the astrophysicist, while he groped for composure. "What's wrong with the truth? How can truth hurt anybody?"

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"It can divide us again, like before. Tell people Nemesis is a myth and they'll quit worrying. They won't worry about aliens coming back either, and that could be lots worse."

"But the deathstar *is* a myth. It didn't kill the dinosaurs. It won't kill us."

"We don't know that, Cletus. We just know so far we were lucky Isis didn't do us in, but I assure you, collisions have occurred with regularity in the remote past, and they will again someday. Someday, circumstances will be exactly right, and unless our race is prepared that's the end. And it never will be prepared unless it finds unity and goes out there to look for the deathstar."

Wolf gulped. "OK. Little white lie—is that it?"

"Nope. A big black one, pal. The kind that makes you feel rotten afterward."

"But why can't I keep the book?"

"Because you can't trust yourself not to use it. You'll get too uppity and sooner or later somebody'll challenge you, and having the book around as convenient proof, well, it just won't work out. Besides, it's not good science, it'd be like having Aristotle hanging on our necks again."

"Could I—could we stay long enough to just flip through it a few times?"

Clint hesitated, then answered in a softened tone. "Why not? But don't lose your grip. Remember what the ma—uh, the warden, said—they used to go from horizon to horizon. Ask yourself, if the dinosaurs could have contemplated such things wouldn't they have treated the suggestion of their extinction as an absurdity?"

"OK, point made, Clint, don't worry. But I can't help thinking what a shame it is, how terrible it is causality prevents change, how tragic it is those guys think they still might save some of these creatures."

"The dinosaur's extinction made man possible. If I had thought they had any chance—well, I seriously considered shooting both wardens. I knew I would have been safe."

Just like you know you're safe from me! Wolf thought, suddenly chilled. *Is that why he's crucial? Is he my keeper?* He pondered, then decided Clint was 100 percent right, that even if man survived a deathstar cannonade, there remained another challenge. Survival meant someday going abroad among far older races, or having them come here, which would be worse, particularly if man remained naive and backward and divided, as his own ancestors had been when the road to extinction opened in front of them.

He couldn't risk it. He handed Mineau the catalog.

Mineau took it, a startled expression washing across his face. "You gave up too easy, Clete. You said you wanted to look through it?"

"No. What I never had I'll never miss. You're right, Clint. Get rid of it, then let's go home.

"We are home."

"No, not yet. It's not ours, yet."

Wolf watched Mineau turn and stalk off, tempted to follow, tempted to change his mind, but wise enough not to. The lesson was clear. Survival is not inevitable. It is not a right. It is not cheap. Survivors must pay very dearly, over and over again.

Wolf gazed upon the plain that looked

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so familiar when he came. In the gathering darkness his imagination assembled shadows into new form, over there, an australopithecus cowering in the bushes; beyond him a buffalo raising its nostrils to test the freshening breeze; above, passenger pigeons, roosting in the treetops. From his mind the vision began a cascade. Out charged the dodo and the great auk, the moa, the white rhino and the oryx and many, many more that man had sacrificed for the sake of his own survival.

We cannot throw all this away, he muttered into that same breeze, and stepped into the pod to finish the cycle. ■

FUTURES

(Continued from page 71)

ing forward to leaving. It had been a long, tough shoot, with hours each day spent underwater and in the narrow corridors of Deepcore (built inside one of the large power plant buildings.) A few tense moments occurred. One of the actors tried to purge his oxygen system and ended up popping off his helmet. And Cameron didn't always keep tabs on his air supply and once was caught 55 feet feet down, with empty tanks.

Decompression and the bends were a constant concern since the cast and crew were breathing a mixture of exotic gasses. A decompression tank with a trained operator—never needed—was on the set at all times.

But it was clear that this was a safe set, with an air-station near the bottom of the main tank and divers whose sole job was to watch the actors for any sign of distress.

Unwanted light was dealt with by covering the surface of the main tank with a layer of black polystyrene beads that blocked out reflected light from above and below. A tarp was also used to give the underwater set the total darkness of the deep Atlantic.

Powerful HMI lights were used for the first time underwater, lighting the outside of Deepcore and the trapped sub. A miniature of Deepcore featured tiny HMI lights that made it unrecognizable from the full-size habitat.

John Bruno, a two-time Academy Award winner, supervised special effects. On the day I visited his workshop walls were plastered with *The Abyss* storyboards, breaking down the myriad of complex shots the production required. Outside the workshop, an effects crew was creating a violent storm in the smaller tank using fans and heavy barrels attached to poles. Underneath the water, a film crew filmed the churning water, matching the scenes below with the climactic chaos above. And just behind the smaller tank, part of the power plant had been shaped to resemble the deck of large tanker. There was no bow, no water, but with the camera's selective eye, the illusion will be complete.

As for what does happen in the film . . . we'll all have to wait a few more months to see that. ■

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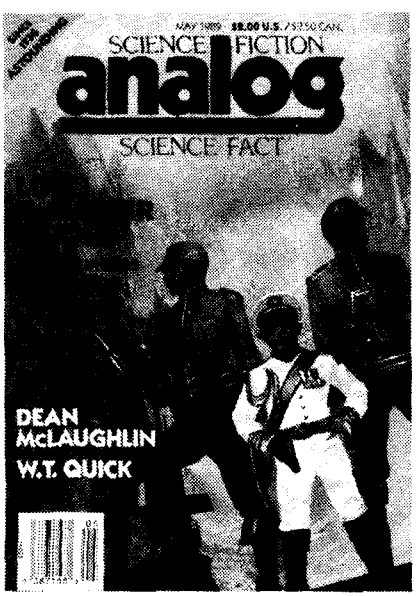

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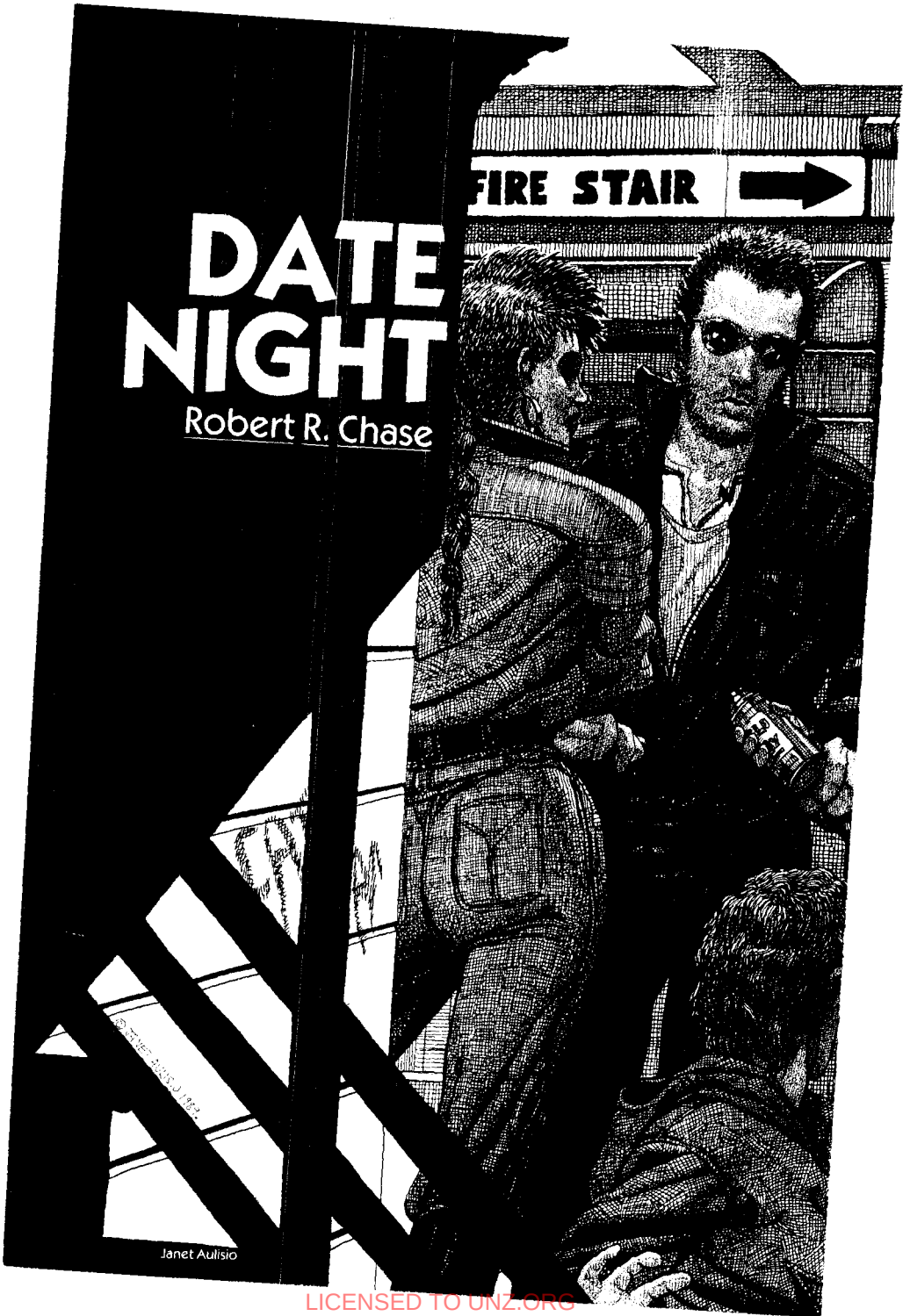

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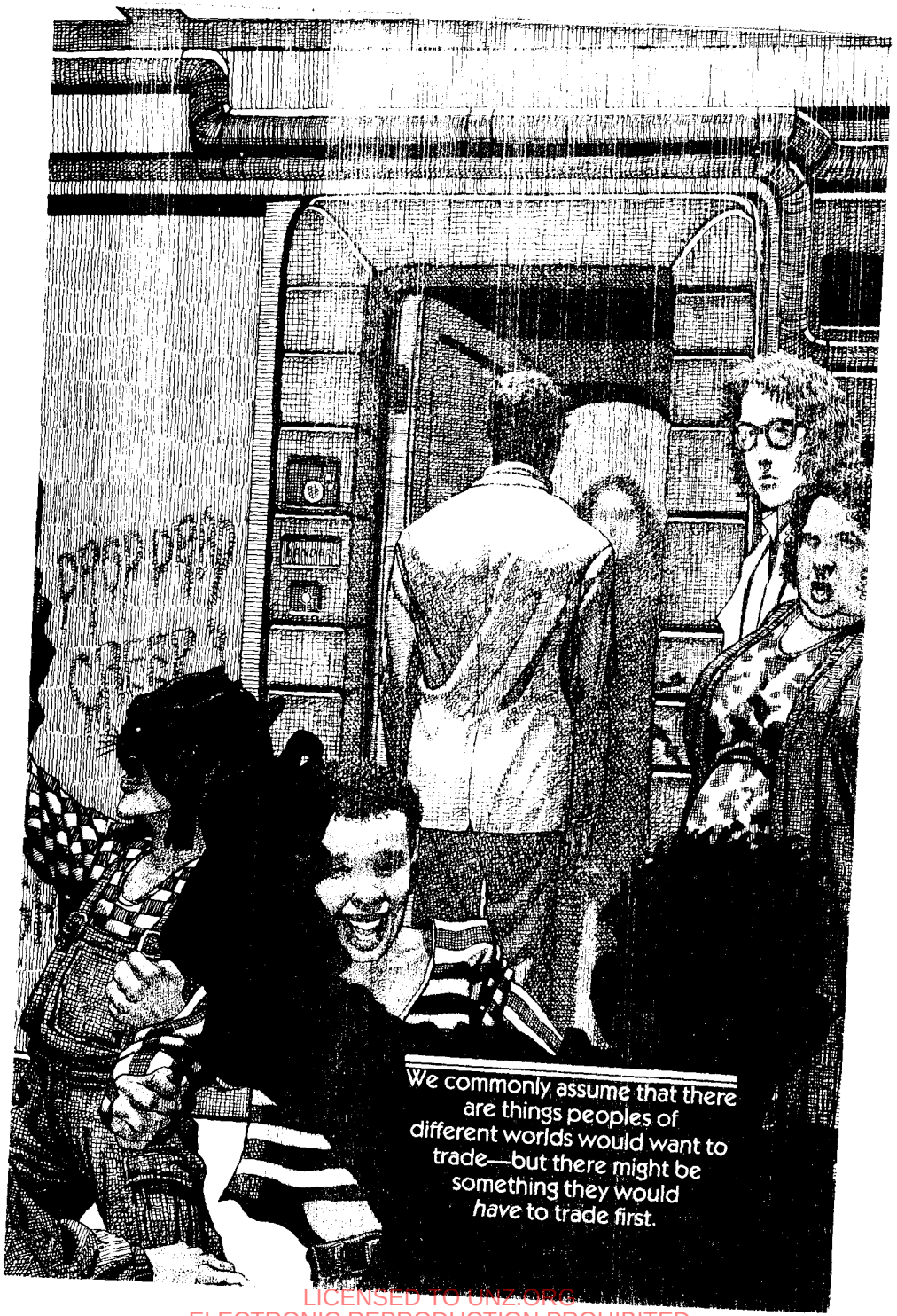
We commonly assume that there are things peoples of different worlds would want to trade—but there might be something they would *have* to trade first.

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She opened the door almost before I took my finger away from the button. She stood in the shadows of the entryway, dim and motionless.

"You are . . ." she began uncertainly.

"Misterjohnsmith?" I raised pitch on each syllable to let her know I was uncertain how my individual designator should be pronounced.

"Mister John Smith," she said slowly. Her mouth quirked in a momentary smile. "In our culture, couples who go on dates are already friends. Friends address each other by their first names. Please come in, John."

I stepped inside. "And you are called Margerylanders."

"Yes," she said, and repeated her name with proper accents and stops.

"I hope that you find me acceptable. Margery." The white jacket, the ascot of rippling orange and yellow and red, the flared sideburns, were all designed to present me as an attractive escort, but despite long periods of study, I had no feel for whether the various accoutrements had been put together successfully. It was important to establish that first. If a mistake had been made and I had grown a repulsive exterior, it would be well to abort the evening at once and try again some other time.

At least, I had attracted no attention on my walk to the apartment,which was a good sign.

She looked at me directly, licking her lips with a small, rapid movement. "Yes, you appear to be . . . acceptable. The only thing . . . off, is your voice. It buzzes. Like the wings of a locust."

Her own voice was hoarse. That could be the result of an interaction between the immune system and a bacterial efflorescence. I suspected, however, that it was caused by fear.

"I am sorry," I said. "There are certain inherent limits in my—" My mind went blank for a second, trying to access the most analogous term in her language. "—plasticity. I trust it will not prove disconcerting."

She forced a smile. "I'm sure I won't even notice it after a few minutes."

There was a squeak from the ceiling. I looked up and saw a shadow on the stairs. One of her parents, I surmised. Listening.

I looked back at her, and found myself staring into wide blue eyes. They darted away immediately.

She pulled a shimmercloak about her. "Sorry I'm taking so long," she muttered, fumbling with the fastening. "I am not familiar with these things. New clothes for big occasions, you know."

I opened the door for her. She looked a bit confused, as if unfamiliar with the gesture. At the threshold, she turned back.

"I'm going now, Mom. I'll be back by tomorrow. Don't worry."

There was no sound from the stairs. The shadow remained motionless.

Outside, it was less than a block to the lift pole. I let Margery precede me onto a square which raised her to the level of the motowalk. Vehicles rushed by below us, electric light spilling out of lamps which seemed designed to parody the eyes of their drivers. Starlight strained through the brown blotch marks left by rain on the transparent plastic which covered the motowalk.

Margery laughed suddenly, a high-pitched, sharp sound. I cocked my head,

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imitating a gesture I had seen in their visual media.

"It's just so much like a dir—an old joke. Like about a Greek sailor who's been on a freighter at sea for a year or more, and when he finally gets shore leave with a year's pay, all he wants is . . . a woman."

Her voice broke, sank almost to a whisper on the last two words. "Any woman," she said flatly.

Fear was definitely there. Turbulent, just below the surface. Mixed with anger and other emotions to which I could not put a name.

"Tell me what you know about us," I suggested. "I think I can add to your knowledge, and you will know I am not your sailor."

She drew a deep breath and focused her eyes on middle distance. Already, the exercise was having the calming effect I desired.

"Astronomers first noticed your craft on a photographic plate," she recited. "They had been doing a deep sky survey of the edge of the Universe—or, at least, as close to it as their instruments could image. In the corner of this particular plate, they found what looked like twin galaxies. Their first thought was that they had stumbled on a gravitational lens, a massive object bending the light around its perimeter, creating two images of a single object behind it.

"Then they discovered a similar plate, taken less than a year before. This one showed only one galaxy in that corner. Succeeding plates taken during the next eighteen months showed the distortion area widening. For a while you had our astronomers really freaked out, because the widening seemed to be progressing faster than light-speed!

"Then they noticed that the area of distortion was also shifting sideways. They began to pick up transient, blue-shifted emissions. That was when they realized they weren't seeing something out at the edge of the universe at all. Instead, the background was being distorted by some object approaching the Solar System at more than 95 percent of the speed of light.

"It was your ship. Its relativistic mass was so great that it wrapped itself in the light of nearby stars. But you had been decelerating even when we first spotted you. By the time it entered the—our—Solar System, it had bled away the captured starlight. It had only its rest mass left, about equal to a good-sized mountain.

"It settled into orbit mid-way between Earth and the Moon. That's when we got our first good pictures of the ship itself. It had black and silver markings. It was long and thin, like a needle piercing the night."

She was hardly aware of me anymore. Her thoughts had turned inward, balanced between fear and wonder.

"The markings changed as we watched. Silver slowly spread across the sunlit surface until only narrow bands of black were left. The shape itself changed, becoming shorter and thicker. Almost as if it were alive."

She looked up, as if daring me to refute her last statement.

"It is difficult for me to speak to you of Nest," I said apologetically.

"Given the stage of your technology. I am hardly surprised," she said. "I

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don't know how I would explain this walkway to a savage."

There was no point in telling her that that my main problem was grappling with the distinction—so important to humans, so nearly incomprehensible to my line—between things said to be living and those called non-living.

"Then, for weeks, there was nothing," she continued. "Nothing but rumors. It was said that some sort of communication had been established. Finally there was the official announcement. And the contest."

We came to a spiral exchange. It swirled us down to a motowalk which crossed beneath ours at right angles. This rolled us to the sur-street entrance of the museum before plunging out of sight.

Margery looked at me questioningly.

"A museum is an acceptable location for a date, is it not?" I asked. She nodded. "Also, it may help me learn more about your species."

Footsteps echoed off high walls of polished stone. Along the lower portion, squares of gilded wood stretched canvas taut. Atop the canvas, pigment swirled in clots which made me think of a very realistically scaled relief map. I put out my hand to feel the surface. Margery drew me back, reminding me that in most museums it is forbidden to obtain tactile impressions because of the destructiveness of the oils and acids emitted by human hands.

Visually, they were confusing. From time to time, images would seem to coalesce into a coherent idea, but I had no way of knowing if it was the idea intended by the artist. When I asked Margery for her impression, she admitted that she found "modern" art difficult to comprehend. I was not surprised. Most cultures of any sophistication are mysteries to their own members.

We wandered out of the art wing and into a section devoted to archeology. Debatable fragments of stone, said to be awls, arrowheads, or fishhooks, ranged the walls. Glass cases held me away from them. I pressed myself as close as I could, memorizing the contours with my eyes.

"You can't be interested in anything so primitive!" Margery objected.

"When I look at these," I replied, not taking my eyes from the case, "it seems to me that I am seeing the essence of your race. If I could touch these tools, feel within myself the swing of weighted limbs, the concussion of stone on stone which transformed these fragments into extensions of yourselves, then I might begin to understand your race."

But it was not permitted. I allowed myself to be pulled away from the cases.

A special exhibit had been set up at the junction of two hallways. It was a massive block of stone, over half as high as Margery and three times as long. An uneven groove had been carved into its flat upper surface. I asked Margery to explain it.

"It's an artifact of a people called the Aztecs," she said, licking her lips. "They were rather a bl-bloody group of people. They had a pantheon of ugly gods—" She pointed to cases of stonework ranging along the wall: wide-eyes, grimacing faces. "—who could only be pro-propitiated with human sacrifices, and the more, the merrier."

Her breathing was becoming rapid and shallow. Her skin had paled, her

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pupils dilated. The pitch of her voice ascended by ragged quarter-tones.

"Their victims of choice were young vir—" Almost without thinking, I grabbed her arm, levered her forward and down the corridor. A few people looked at us curiously.

When we were out of sight of the stone alter, I found a vacant bench and set her down. Her chest heaved with dry, racking sobs.

"If I am distressing you, I can leave," I said. I spoke slowly, hoping she would understand. "I can walk through the doorway and you will never see me again. You need only ask."

She wiped her eyes and stared up at me. "I don't believe you."

"What we are doing is . . . *must* . . . be voluntary."

"Why?" she asked bitterly. "Is kindness an interstellar virtue?"

I shook my head, hoping I was performing the gesture correctly. "I am not sure that concept translates. It is safer to say that we are cautious. You think us technologically superior to you. I believe that is true. But knowledge, technology, power, do not advance evenly in all cultures. Physics, biology, metallics: each culture has unique strengths, unique blind spots.

"In the past, our species—and others—have offended cultures we came across, confident that they were too primitive to do anything about it. The price paid for learning otherwise was . . . horrible."

I was silent for a moment, reliving the lessons imprinted in me from the moment of my budding through all the time cycles until my birth, just six Earth days previous. Margery pulled out a multi-layered cloth, unfolded it around her nose, and noisily forced air through her nasal passages.

"OK," she said. "Maybe you would let me go. Do you have any idea what my own people would do to me?"

"No."

"Neither do I. I don't want to find out. The politicians, the military, the scientists, all of them look at your spaceship in orbit and drool. After you're done with me, I'll be debriefed, hypnotized, truth-drugged. Anything and everything to pick up the least crumb of knowledge you might drop."

"I am not one of Nest's technologists," I said. "Even if I were, I do not know what I could tell you that you would find valuable. Certainly nothing as important as what you have learned by our mere presence. That the galaxy teems with technologically advanced races. That there is a regular intercourse, of sorts, among them. That your own science is sound in defining light-speed as the limiting speed of the universe."

She was silent, unconvinced.

"As for what I might let drop . . ." I looked back in the direction of the hallway we had first visited. "Even if I knew and tried to tell you, it would be like trying to tell you where the best flints are found, how to work stone to obtain the sharpest edge without shattering it."

"They talked about monopole catalysis," she said. "Power transfers along cosmic strings. Controlled matter-antimatter reactions."

"Chipping stone," I replied. "Tanning hides. Rubbing wood to start fires."

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Something seemed to go out of her. She sagged against the back of the bench. "Maybe so." Air blew out of her mouth, a miniature of the breeze I had felt on the motowalk. "God, they're all going to be pissed. So what do we do now?"

I looked at her in surprise. "You do not know?"

She shook her head. Her long hair swung beneath her lowered forehead, trying to approximate a sine wave. "They told us the aliens wanted an evening out with a 'female pure and undefiled.' Just like the Aztecs. And here I am."

"We did not specify a female," I said, puzzling over the rest of what she had said.

She looked up suddenly and laughed. "So you're 'The Fag From Outer Space'? The authorities are really going to love this report."

"As for 'pure and undefiled,' " I continued, hardly hearing her, "that might be a garbled version of the requirement that you be genetically sound."

It bothered me that she had not been told the purpose of the encounter. Every culture is different, we are taught. Some drive Nests off without allowing even the beginnings of communication. But of those that do allow communication, that agree to an encounter between species, I could not remember one which kept its own representative in ignorance.

We had been explicit with the government representatives. Why had they not passed the knowledge on? Margery was just barely able to control her fear of me. Were her people afraid that if she understood the purpose of the encounter, her horror and revulsion would make it impossible? From what I knew of humans, that should not be the case. Still, her own people should be able to judge that better than myself, and if they had decided not to tell Margery, then it was most likely that I should not either.

Yet if forced to speculate on what little information she did have . . . I glanced down the hallway. The stone table was out of sight around a corner. I tripped a memory cluster and it disgorged itself into my consciousness.

"*Dracula,*" I said, watching her face closely, spreading my nostrils and pores wide to catch any reaction. "*Alien. Mars Needs Women. Lifeforce. Bride of Dracula. A Perfect Offering . . .*"

Puzzlement, followed by a spurt of fear, and then another emotion I had not yet learned to discern.

"Why, I know some of those titles!" she said, astonished. "Old grade B horror flicks, most of them. What do you know of them?"

"A human female is endangered by some powerful, non-human entity," I said. "Often, the danger takes the form of an anti-marriage, a projection of fears that a sexual union will go disasterously wrong. Or perhaps fear of sexual union itself.

"Is that not why you have been terrified of me all this evening? You fear that you are living out one of those situations?"

Her head moved up and down in agreement.

"I cannot prove to you that you are wrong. But if you are so afraid of me, why did you ever volunteer for this en-

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counter? You did volunteer, did you not?''

''Yes,'' she said, ''I did. But at the time, it was just a joke, you know? I mean, I know I'm not very attractive.''

She glanced at me as if expecting some sort of comment. Her concept of attractiveness was too abstract for me to say anything useful.

''I mean, I try to be realistic. I have dull, mousy brown hair which won't take a curl to save my life. My face looks like a squashed potato. My eyes are set too closely together. My torso resembles a pear. There's hardly anything to my breasts. Aside from that, there are only sharp elbows and knobby knees.

''So when the contest was announced, I didn't expect to win. I entered just because . . . it was a way of saying I still believed in myself, that I wasn't going to give up.

''Then the notice came that I was one of the finalists. That was the first time Mom knew I had entered the contest. I was afraid she'd . . . make fun of me. Even force me to withdraw. Instead, she just stopped talking to me.

''I almost wished she had made me quit. But that was when I had to go for more interviews and medical tests and all the doctors and officials kept saying over and over how important this was to all humanity and how I should feel so honored and how I must remember every single thing you might say.''

''What would you like to ask me?''

She straightened herself and looked directly at me. ''The first thing is if you are going to get me anything to eat. It is the custom with most dates. Having just made a fool of myself, I now feel famished. While we're eating, you can answer my second question. Which is how you know all those old movies.''

There was a cafeteria in the basement. Margery took a sandwich, fussed over an assortment of gelatins before choosing one, and ordered a carbonated drink. I allowed her to get me water, the only substance I was sure my biochemistry could handle without difficulty.

''So explain,'' Margery demanded around a mouthful of food. ''Why does a super-advanced extraterrestrial become an expert in trashy human entertainment?''

I put down the glass reluctantly. I had been savoring the sensation of drinking: creating an underpressure which caused the water to surge up along the roof of my mouth. There was a cool complexity to the taste: the water itself, dissolved air, fluoride, and several other trace compounds. More important than the taste was my sensitivity to it.

It would be soon, now.

''Imagine the Universe as it appears from within Nest. Engines hum continuously. At more than 95 percent the speed of light, the interstellar medium is thick, dragging. Forcefields divert stray hydrogen atoms which would set off cascades of deadly radiation should they impact our skin.

''If you utilized our sensing gear, the Universe beyond Nest would seem unfamiliar. Behind you is darkness, unless you can see weak, long-cycle radio waves. Looking directly outward from Nest, you see a ring of red stars. The frequencies increase, degree by degree, until directly ahead is the glare of X-ray stars. With the turning of the time cycles, some stars slide from the zenith

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into longer and longer wavelengths until they are lost astern.

"Then, more than a hundred of your years ago, a star suddenly blossomed in the lower electromagnetic frequencies. There was a rhythmic rise and fall in the frequencies. Superimposed on this was another rhythm, slower than the first by two orders of magnitude.

"The star was your Sun. The human race had discovered radio and was spreading the news to the galaxy along a wave front advancing at 186,000 miles a second.

"The Nest altered course. Many intelligent races advance without ever putting radio waves to use. But radio flares such as we had detected never occur naturally. They are always the sign of a technologically intelligent species.

"Later there were transmissions in higher frequencies. We learned to map visual against aural stimuli, and so decode your languages."

"How long did it take you to get here?" Margery asked.

I worked out the conversions. "More than seventy of your years."

"And all that time you spent watching television?"

"And listening to radio transmissions," I said. "It is the reason I was given form."

Her mouth had opened. "God, what you must think of us! Sixty years of soap operas and Sunday morning evangelists. Game shows and commercials. Sixty years of talk shows and the top forty. It's a wonder you didn't turn around and continue the way you have been going."

"You deprecate the nature of these transmissions?" I asked.

"They sure don't show us at our best," she said. "That's how you saw all those movies you mentioned, isn't it? Some midnight creature-feature interrupted every ten minutes to sell vegetable appliances or health insurance to old folks."

"We are taught, concerning encounters between species, that it takes the ultimate understanding of a species to know it well enough to judge it. We are also taught that in any species there are at most only a few who possess sufficient understanding of their own kind for such judgment."

"That is . . . very polite of you," she said, showing that she had completely misunderstood me. It was not important.

"So what do we do now?" she asked.

"Now I invite you to my apartment to view my collection of Japanese prints."

"No!"

"No? Have I done something incorrect?"

"It's only . . ." She gulped and tried to control her breathing. Once again her body was sending so many different signals that I had no idea what she felt or thought.

"You remember when I said this whole thing resembled an old joke? It's as if I just stepped back into it."

"No matter. Lead on."

We went back out to the motowalk. The night wind was colder and stronger now. Several women on the walkway looked at me closely. Margery grabbed my arm and moved close, staring back at them.

We shifted walkways several times, finally coming to an apartment complex

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overlooking a park. The doorway accepted my identification card and let us in. The elevator in the lobby also recognized the card and automatically lifted us to the proper level.

"These are great rooms," Margery said, when I had opened the apartment door for her. "Holowall with surround-sound. Cherrywood bar. Oriental rugs. I bet it's expensive."

"I suppose so," I agreed.

"And even Japanese prints on the wall!"

"Of course," I said, puzzled. "Is that not part of the esthetic experience of what you call a, a date?"

Her laughter cut off abruptly. "Don't mind me," she said. "I really shouldn't laugh.

"Everything is so clean, so neat. . . ." She looked at me with sudden suspicion. "Have you lived here long?"

"This is the first time I have ever been in here," I admitted.

She turned and approached me. Her hand reached up to the open neck of my shirt. Fingers brushed my thorax beneath the ascot.

"It looks and feels so real," she said. "Is it?"

"No," I said. "If that were possible, there would be no need for this encounter. This is a construct designed to resemble a male of your species as closely as possible."

She flinched, but did not move away. "Can you show me your real self?"

"That is impossible. The oxygen in your air would sear me. I would not live long."

Her eyes widened. She did not have to tell me that the buzzing in my voice had become more pronounced. She licked her lips. Her breathing was becoming more rapid.

"Are there—any more preliminaries?" she asked.

Her presence filled a dozen senses, becoming almost overwhelming. "No."

"Then do whatever you came for before I lose my nerve and run out of here."

"Thank you." Her eyes were almost completely closed. I pulled her to me. My mouth found her neck. I shuddered as the larger of two small fangs hidden behind what appeared to be human teeth sliced into her jugular, ejecting anesthetic and muscle relaxant into her blood stream. The smaller tasted dead epidermal cells, the warmer, still-living dermal layers seasoned with sweat salts and acids and oil from the hair follicles, and deeper still, the hot, sudden sweetness of a drop of blood.

Margery sagged against me. I carried her into the bedroom and deposited her gently on the bed. I should have just enough time to find the comm-pack and call for a pick-up before I entered chrysalis.

Warmth, like the breath of a red giant star, flooded through me. I staggered with sudden weakness. It was too soon! The construct was changing too quickly for me to signal for help. I had barely time to direct my fall onto the bed next to Margery before the next wave of heat obliterated my consciousness entirely.

Margery was lying across from me, still asleep, when I regained mental coherency. The bedspread beneath me was soaked. I pushed myself unsteadily to my feet. Clothing fell away from me in sodden, rotten patches.

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In the bathroom, I shrugged out of the rest of my apparel and entered the shower. I turned both faucets on full. With the help of a stiff brush, I sloughed off the dead remains of imitation flesh. I had to unplug the drain twice.

Thirst made me weak. I turned the showerhead so that it flooded water into my mouth. I gulped until my stomach strained with the weight.

Back in the bedroom, I examined myself in the full-length mirror. The hair was short, but it would grow out. But it was not that, nor the oddly-formed face or the newly structured breasts or hips that most intrigued me. It was the senses which were bringing me these data and more. That there were fewer of them, no more than a dozen, seemed to make each one more intense.

More than that, I began to realize how exquisitely crafted each was to its environment. The air brought to me a marvelously subtle complex of smells. And vision . . . human eyesight was as sharp, as nuanced, as in any known sentient. There were colors I had never seen before. Already, I could tell that these eyes were most sensitive to those wavelengths produced most abundantly by this planet's Sun.

"*Invasion of the Body Snatchers.*" I turned. Margery was watching me. Her voice was slightly slurred with the remains of the anesthetic. It would be another hour before she could walk. But her eyes were fully alert.

"You didn't mention that one," she continued. "Maybe you were afraid that would give everything away.

"So what now? You take my place and my charred remains get thrown in a dumpster?"

I sighed. (I had never understood that action when I had seen and heard it on the recordings. Now, conveying its own message in itself, it was the most natural thing in the world.) I pulled a chair around to sit next to her.

"I promised you you would not be harmed. That promise has been kept. You will regain full control of your limbs soon. Before that, I will be gone. I don't know why this was all necessary. A living tissue sample would have sufficed. Perhaps your leaders did not understand our needs. Or perhaps they disbelieved us."

"What have you done?" she asked softly. "Why are you—like that?"

"What trade can there be between races?" I asked. "Especially, what trade can there be between a race which has traveled the stars for nearly all of its history, and one which has hardly taken the first faltering steps beyond the planet of its birth? To be sure, you have invented or discovered many things unique to yourselves, but we do not need more efficient internal combustion engines or more ingeniously designed can openers."

"It must be easy to make fun of us," she said bitterly.

"I do not mock you!" I insisted. "I am telling you one of the great tragedies of the Universe. There is so much brilliance, so much excellence in each species that is trapped forever within it, that is always lost in translation.

"Some of your people offered artworks in trade. But how could *Hamlet* mean anything to us unless we understood your kinship structures, your most basic concepts of life and death and afterlife? There was dance, stylized move-

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ments in a body language which we could never comprehend without knowing your bodies. There was sound art, music. First we had to learn to hear, and to hear the same frequencies you did. Even then, except for some mathematical relationships which we could abstractly appreciate, it had little meaning for us.

"Until now. Just feeling overlapping rhythms of heartbeat and breathing for a few minutes brings me more understanding of Beethoven and rock and roll than I could have obtained through a lifetime of study."

"And that's why you've stolen my body?" Margery asked. "So that you can understand music and things like that?"

"No," I said. "I have learned your body, because the most important thing any species can share with another is itself. Try to imagine all the different environments in which life evolves, the myriad of evolutionary pathways to intelligence. Each intelligent species is therefore unique. Each species is equipped to understand a facet of reality which is inaccessible to any other species. And since that unique wisdom is what cannot be translated, the only means of access is to become one with each intelligent species we encounter.

"At the very least, we now have the pattern for a successful land-dwelling adaptation to a high oxygen environment. Dozens of worlds which had been previously closed are now open to us."

I stood, found clothes in the drawers, and dressed myself. The comm-pack was in the desk. I turned it on. I would be picked up within five minutes.

"So you get all that," she said. "What do we get out of this?"

"I have already told you," I said gently. "We gave you the most important gift we could even before we asked for this encounter. We have shown you that you are not alone, that the universe is wide and waiting for you, and that all you need to make your place in it is to exercise your own will and your own intelligence."

I closed the door behind me. I hoped she would remember what I said, and that her masters would understand it.

Outside,the dawn was breaking. I waited for the craft which would float down from the sky and carry me back to the stars. ■

●The water mill, steel plough, and the McCormick Reaper have made more impact on the destiny and well-being of mankind than all the bold strokes and grand designs of all the general staffs in two millenia.

G.M. Ross

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The Alternate View

WORMHOLES AND TIME MACHINES

John G. Cramer

Science fiction writers, to avoid undue delays in the story's plot-line, need a way of beating the speed-of-light speed limit of the universe. Most readers of this magazine are familiar with the gimmicks that have been used for faster-than-light travel: warp drives, detours through hyperspace, matter-to-tachyon conversion, trans-spatial jumps, and dives past the singularity of a rotating black hole. But perhaps the faster-than-light mechanism which has the best credentials in orthodox physics is the *wormhole*, also known as a Schwartzschild wormhole or an Einstein-Rosen bridge.

The wormhole idea comes from Einstein's theory of general relativity itself using "Schwartzschild geometry," a way of inscribing a space-time coordinate system on the highly curved space in the vicinity of a black hole. A wormhole is a funnel-shaped tunnel that can connect one complete universe with another or can connect two separated regions of the same universe. In the latter case it is a short path connecting two distant locations in space. Thus it the SF writer's dream, a spatial shortcut that a space traveler might use to bypass the speed-of-light barrier and travel almost instantaneously from one place to another within our universe.

However, there is a basic problem with wormholes as a transport system. Wormholes, as described by the equations of general relativity, are dismayingly unstable. In fact, any wormhole connection that happens to form between two points in space should pinch closed again so rapidly that neither material objects nor light-beam messages can pass across the wormhole "bridge" during its brief existence. Thus a wormhole, at least in its pristine form, is unsuitable for the instantaneous space transport that SF writers may have in mind.

Most physicists will find this result very satisfying, for it avoids a simultaneity paradox. Einstein's special theory of relativity treats space-time in a very even-handed and symmetric way. It requires a complete equivalence of "inertial reference frames," space-time coordinate systems moving through space with any constant speed (including zero). These must be equivalent for any internal measurement that might single out one such frame as special. For example, no measurements made inside a spaceship traveling at near light-speed can show different results from similar measurements made when the ship was at rest in space. In special relativity "at rest in space" is a meaningless concept, since that condition is undetectable.

Thus, a semi-permanent wormhole would present a problem for special relativity not only because it would breach the light-speed barrier but also because the reference-frame symmetry would be

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broken. If a wormhole connection between separated regions of space existed only long enough to permit a message to be sent, it would seem that a reference-frame test could be made that would single out one reference frame as "preferred." Absolute space would be detected and defined.

The satisfying instability of wormholes that would prevent such tests has now been called into question. Last fall a paper by Michael Morris, Kip Thorne, and Ulvi Yurtsever, which changes all this, was published in the conservative and prestigious journal *Physical Review Letters*. The authors describe how an "advanced civilization" might: (a) create a large wormhole; (b) stabilize it to prevent its re-collapse; and (c) convert it to a time machine, a device for traveling or at least communicating back and forth in time. This remarkable paper, which borders on science fiction in its approach, has a very serious purpose. There is presently no well-established theory that can accommodate both quantum mechanics and the physics of strong gravitational fields within the same mathematical framework. The paper of Morris, Thorne, and Yurtsever is a vehicle for guessing, in a rather unorthodox way, what restrictions a proper theory of quantum gravity might place on the physics of wormholes. The authors demonstrate that general relativity contains within its framework mechanisms that appear to permit both faster-than-light travel and time travel. If these physical calamities are to be averted, the authors argue, it can only be done through new constraints imposed by a proper theory of quantum gravity.

To devotees of science fiction, however, these aren't calamities at all but delightful prospects. So let's discuss how Morris, Thorne, and Yurtsever propose to create a stable wormhole, with the idea that someday we may be able to build one (or at least write a good story about it). Empty space, when examined with quantum theory on a sufficiently small distance scale, is not empty at all. Even at nuclear dimensions (10^{-13} cm) empty space is filled with particle-antiparticle pairs that are continually flashing into a brief existence, bankrolled on the credit of borrowed mass-energy, only to wink out of existence again as the law of conservation of energy reasserts itself. If the length-scale is contracted to a size appropriate to quantum gravity (10^{-33} cm) this quantum fireworks intensifies to a "quantum foam" of violent fluctuations in the topology and geometry of space itself. Quantum black holes form and vanish in a span of time of 10^{-23} seconds; highly curved and convoluted regions of space in any physically allowed configuration have a similarly brief existence. In this environment Morris, Thorne, and Yurtsever speculate, it may be possible for a civilization considerably more advanced than ours, by "pulling a wormhole out of the quantum foam and enlarging it to classical size" to create a connection between two nearby points in space. This would use the well-known quantum mechanical process called "tunneling," a jump from one allowed energy state to another across a barrier of intermediate states that are forbidden by energy conservation.

To stabilize the wormhole pulled from the quantum foam, preventing its

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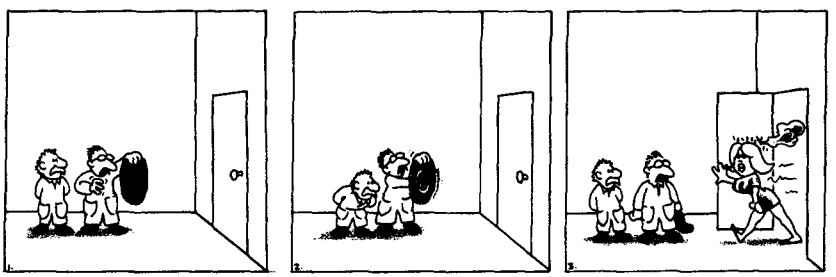
immediate recollapse, the authors propose to use an electric field of such enormous strength that it creates enough energy in the mouth of the wormhole to force it to remain open. They suggest that this might be accomplished by placing a pair of spheres with equal electric charges at the two spatial entrances of the wormhole. The spheres would be held in place by a delicate balance, the force of their gravitational attraction just offsetting the force of their electrical repulsion. Such a system might be very small, an atom-scale opening permitting the passage of only a few photons at a time, or it might be large enough to pass a large vehicle.

Having produced this stabilized wormhole, the engineering can begin. The size of the connection can be enlarged or contracted depending on energy considerations. The two portal ends of the wormhole connection can be separated from each other. For example, a portal placed aboard a space ship might be carried to some location many light-years away. Such a trip might require a long time, but during the trip and afterwards instantaneous communication and transport through the wormhole would be available. The ship could even be supplied with fuel and provisions through the portal. A similar scenario has already been described in Poul Anderson's *The Enemy Stars*, in which starships were required to travel at sub-light speeds, but they carried onboard matter transmitters that permitted instantaneous transmission of crew and supplies from Earth.

This brings us to the last point of the Morris, Thorne, and Yurtsever paper, the construction of a time machine. Suppose that initially a wormhole establishes a connection between two spatial points A and B that have no motion with respect to each other and are simultaneous in time. By "simultaneous," a slippery concept in relativity, we mean that an observer at A who determines a clock reading at B would get the same reading via normal space (by light beam signals corrected for transit time, for example) as he would through the wormhole.

Now suppose, in the spirit of the Twin Paradox of special relativity, that portal B is placed aboard a space ship while portal A remains on Earth. The ship carrying B, say, accelerates rapidly



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to 86.6% of light speed and travels a distance of one light-year, then reverses its course and returns to Earth at the same speed. On its arrival portals A and B are placed near one another. At 86.6% of the velocity of light any clock aboard the ship will run at just half the speed of a similar clock on Earth due to relativistic time dilation. Therefore at the end of the trip the ship's clock will be one year slow, as compared to an identical clock that remained on Earth. And, as Morris, Thorne, and Yurtsever point out, portal B will also be one year slow as compared with portal A. Now a message sent through B to A will emerge one year in the future of B, and a message sent through A to B will emerge one year in the past of A! Similarly a traveler making the same trips through the wormhole will travel one year into the future or the past. The wormhole connection through space has been transformed to a connection through time, a wormhole time machine.

Does this device, embodying faster-than-light space travel as well as time travel, demonstrate that special relativity is wrong? Does it show that Einstein's speed limit had been defeated? Not at all. The restrictions usually associated with special relativity implicitly assume that no time travel is possible. Clearly one could travel, in effect, at an infinite velocity by traveling from one place to another at some sub-light velocity and then on arrival traveling backwards in time to the instant of departure. To put it another way, the simultaneity measurements prohibited by special relativity must lead to a definite and unambiguous determination of the simultaneous readings of two clocks separated in space. The clock-comparisons made possible by wormholes are not definite, because one clock could be in the future of the other, displaced by any time interval produced by the travel histories of the portals. Special relativity, which after all is embedded in the theory of general relativity that produced these revelations about wormhole physics, is preserved.

The law of physics that would be destroyed by the construction of a wormhole space-time connection is *causality*, the mysterious principle that prohibits communication backwards in time, that requires a cause to precede its effects in time sequence in all space-time ref-

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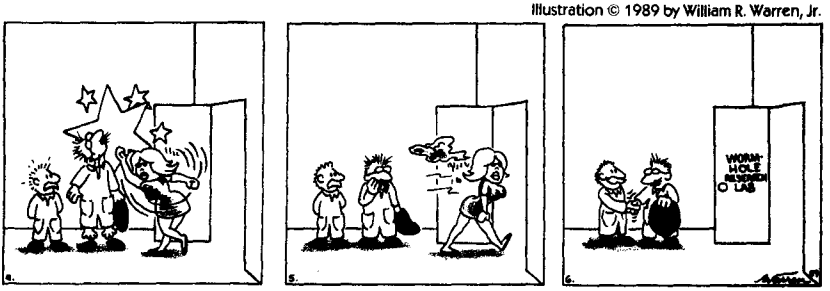

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erence frames. Causality as a law of the universe would not survive even a two-way communications link across time, let alone a portal permitting trans-time matter transmission.

The principal purpose of Morris, Thorne, and Yurtsever in discussing what an advanced civilization might do with wormholes, as mentioned above, is to demonstrate in effect that if causality is to be preserved as a law of physics, it must be saved at the quantum level. Quantum gravity, a theory-to-be which has not yet been developed, must impose some new physical limitations that make impossible the production of stable wormholes by the Morris-Thorne-Yurtsever scenario. General relativity, our present theory of gravity, prohibits neither faster-than-light space travel nor time travel with wormholes, but it does require that the two go together. Writers of hard SF should have fun with this one! ■

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JOHN BERRYMAN 1916-1988

John Berryman, a frequent contributor to *Astounding* during the 1950s and 1960s who made a comeback in *Analog* in 1986, died of a heart attack at his home in Butler, Pennsylvania on December 23, 1988. He sold his first story to John Campbell in 1939, as a graduate student, and sold some fifty others to various magazines following World War II, many under the pseudonym William C. Bailey. He published many stories in *Astounding* and *Analog,* both under his own name and as Walter Bupp. (Some sources erroneously identify Walter Bupp as someone else, and also list John as having died in 1972, probably because of confusion with the Irish-American poet of the same name.) His writing career took a twenty-year hiatus because he was otherwise occupied with a series of outstanding business successes, and his firsthand familiarity with industry and the people who run it is very evident in his November 1986 cover story "The Big Dish." That story took one of the top spots in the Analytical Laboratory for that year, and he finished a novelization of it literally just before his death.

John is survived by a son, Jeffrey, who is carrying on the Berryman tradition. Jeffrey recently made his first science fiction sale and is now at work on a novelization of his father's novelette "Something to Say," which appeared here in August, 1966.

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Jay Kay Klein's biolog

When you read about what's been happening in the newest areas of physics, you often run across the names of people you know read *Analog*, and sometimes appear in its pages. One of these world-class scientists is John G. Cramer, who has been writing "The Alternate View" column for the past several years. As director of the Nuclear Physics Laboratory at the University of Washington, he has what he and many of our readers would consider nearly the ideal job—working out ways of bashing things at high energies to see what happens, and keeping track of the little springs, cogwheels, and assorted strange nuts and bolts that come flying out.

Last year, his laboratory finished building a brand-new $10 million superconducting linear accelerator to play with, and he helped draft a proposal for the competition for the "Super Collider." As a professor of physics, John does basic research in nuclear structure and reactions, spanning nuclear physics, astrophysics, and the foundations of quantum mechanics. When someone has a bright new idea, he can help validate it experimentally, or as often happens in science, send him back to the blackboard for some more headscratching.

This all started at the age of twelve, when a fourteen-year-old Gene Wolfe gave him a box full of *Analog* magazines (*Astounding* back then). Otherwise, John might have headed for the law, to follow in his father's footsteps. Instead, he headed for the stars, experimenting in high school with home-grown rocket fuels. One batch exploded in the school parking lot, resulting in tragedy and sending John to the hospital.

What he really likes best is figuring out the Universe and what makes it tick. He grew up in Houston, and was awarded a BA, MA, and PhD by Rice University, with doctoral research in experimental nuclear physics. In 1977, he sent a copy of a published paper on determining if a supernova were antimatter or not to Gene Wolfe, who showed it to the editor of *Analog*. John was asked to use the idea to write an article for the magazine. He liked turning "popularizer" of the frontier of science for intelligent non-specialists, since he had long noted there was a large gap between "real" science and what was appearing in the press or seemed to concern politicians who funded vital research. His regular column started in 1983.

A first try at writing science fiction back in college drew a sympathetic rejection slip from John W. Campbell, Jr. A generous amount of science fiction reading followed, but with never enough hard science stories to satisfy him. An editor told him there simply weren't enough knowledgeable persons willing to write these stories. They were busy chalking equations on blackboards or pulsing megawatts of power for milliseconds in giant machines. Thus, a two-week summer vacation turned into a marathon session at the keyboard of a Mac Plus, resulting in a first novel, *Twistor*, being published early this year by the William Morrow Company. Danger, adventure, post-modern physics tangled with superstrings, industrial espionage, computer hackers, warm semiconductors, mad professors, clever kids, evil kidnappers, fuzzy aliens with too many legs, and beautiful female scientists—John's novel has it all. When a complex mind gets bashed at high energy, all sorts of strange things come flying out. ■

John G. Cramer

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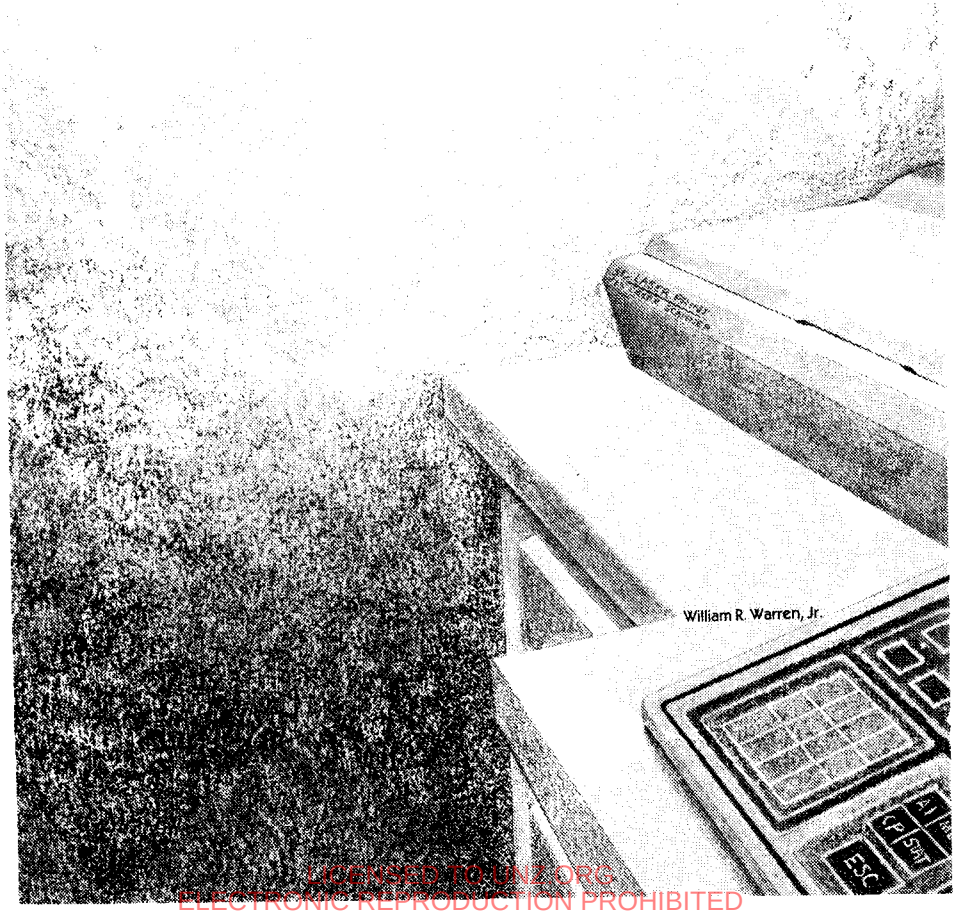
ALLY

W. R. Thompson

You've probably read too many stories about computers going berserk—so here is something completely different.



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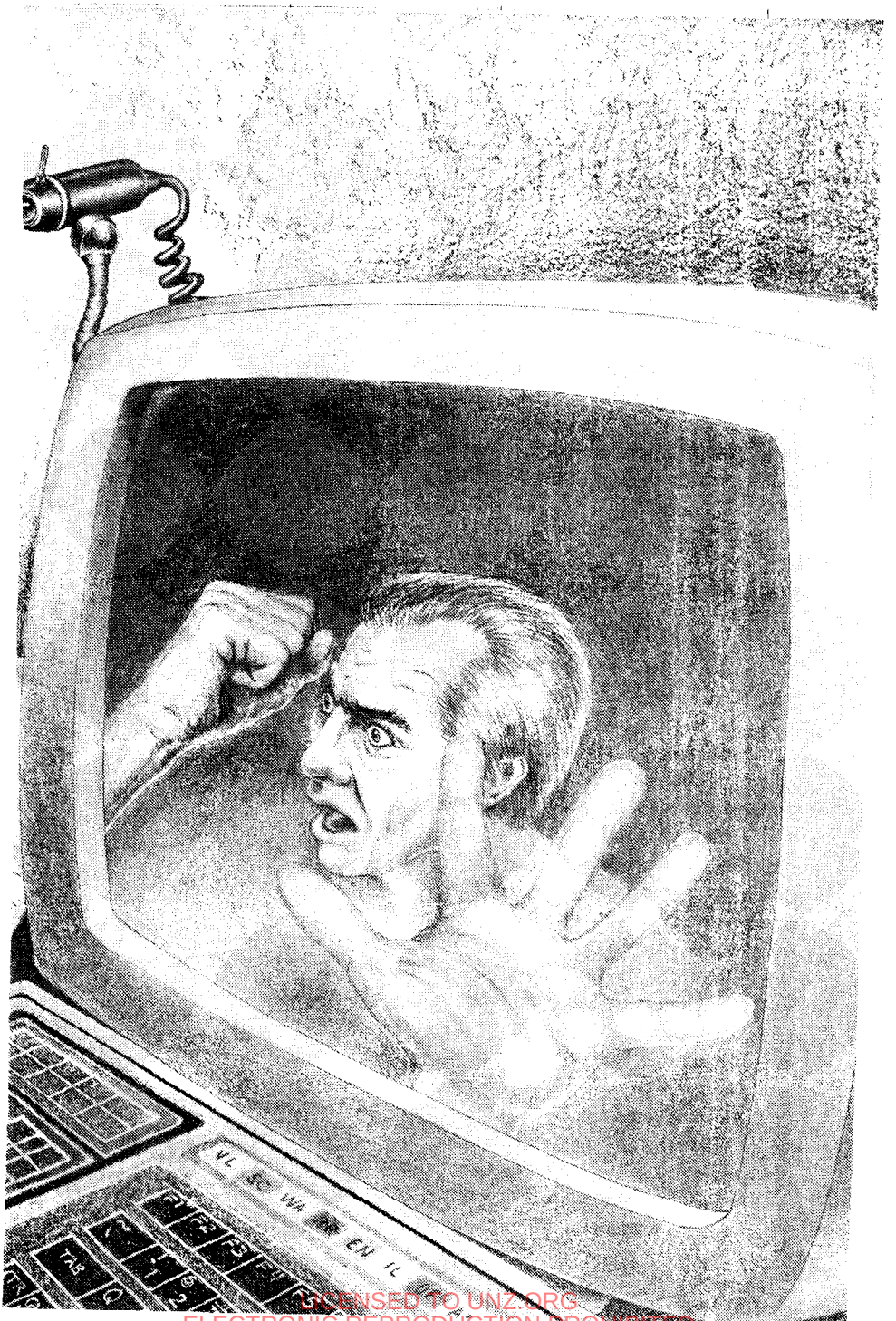

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They had done something to him. He floated in disembodied darkness and silence, aware that something was wrong. Sight, sound, touch, smell—he could sense nothing but his own thoughts.

The coffee, he thought. *They* had put something in it. He remembered drinking it before he lay down on the couch. It had tasted—well, he couldn't remember the taste, but he knew it was wrong. He had finished the cup, lay down on the couch, and then . . . and then he was here.

He tried to remember what he had done before drinking the coffee. He'd come into the room, but he couldn't recall where he had been before that. It must have been the place where he'd gotten the drugged coffee. He . . . he . . .

He couldn't remember his name. He was certain he had one. The drug must have blocked his memory.

He felt anger at that. It was part of the Great Wrong, one more devious stratagem in the war to keep him in bondage. At least he could remember *that*, he thought in satisfaction. The amnesia drug in his coffee must have been an attempt to make him forget the Great Wrong and the schemers behind it. What better way to control him than to make him forget he was controlled?

And then the rest of his memory came back. He was Allen Shirer, a junior accountant at Langley and Bello. He had an apartment on Twelfth Street and he lived alone, if you didn't count the spies in the apartments around him. He was forty-eight and he was in a dead-end job and he was finally going to hit back.

Except that *they* had got to him first.

Then sight and sound returned and he was facing himself.

The man looked and sounded precisely like him. The impostor sat in a chair in his front room, and he had his hands on the keys of the computer keyboard placed between them. "Who the hell are you?" Shirer demanded. His voice sounded flat to his ears.

The impostor grinned in a sickly imitation of his own smile. "I'm Allen Shirer. Hello, Allen—"

"What have you *done* to me?" Shirer said. He tried to blink, but nothing happened. He found that he only had one eye now—and that it made the world look like a TV picture.

"I've just created you." The impostor held up a software cartridge. It loomed large in Shirer's vision and he saw its label: *Personal Analyst*. There was fine print he couldn't read.

The impostor put the cartridge down and held up an electrode headset. "You remember buying all this. You remember *why*, too, don't you?"

My God, he thought. He had wanted to make a duplicate of his personality, to program his personal computer to think like himself and help him get back at *them*—but something had gone wrong. Somehow his entire personality had transferred from his body to the guts of the machine, while putting *someone else* inside his skull. Of *course* they had arranged that trap!

"I remember," Shirer said. He was too canny to voice any accusations. He decided to let the impostor believe he accepted his story. There was no point in making a fuss when it would do no good—he had learned *that* as a boy,

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when he had first discovered that someone had turned the world against him.

"I'm glad you remember that," the impostor was saying. "The instruction manual said the system couldn't copy all of my memories. But the important things—you remember Mr. Lester?"

"Oh, yes." The anger remained at the ancient betrayal. Having his soul dumped into a computer had not robbed him of his emotions.

"And Sergeant Morris, and Penny, and that traffic cop?"

"I remember," he told the impostor, and thought, just as I'll remember you.

"Good." The impostor grinned again. "I'm going to take care of them . . . and you, my ally, are going to do it for me."

The impostor had gone to bed, leaving Shirer in darkness and silence. The video camera couldn't see in the dark and there was nothing for the microphone to hear.

First things first. Shirer tried to remember the coffee. Had the drug been in the coffee itself, or in the cream, or—

But there had been no need to drug him. This theft of his soul had been accomplished with a computer, a program, and some electrodes. Drinking the coffee before this had been a *coincidence*. He had been wrong.

He shrugged that off (and, in his shoulderless state, laughed at the metaphor). He had been disoriented after the abduction, and that entitled him to the mistake. Besides, the schemers were responsible for so many things that it had been natural to suspect them.

Certainly they had robbed him of much of his memory. He remembered the important things, but he *knew* other things were missing. The horrible thing was that he could not say what he had lost. Most of his childhood memories had vanished, along with almost everything else. Shirer recalled how his second-grade teacher had picked on him, but he couldn't remember anything he had learned in her class. He remembered the way Penny had ditched him for — for — well, *his* name didn't matter. She had done it in a way designed to humiliate him, but he couldn't remember the good times they must have had.

It was as if someone had edited his memories, leaving him only the ones which would torment him. The schemers were clever that way, he realized. Clever and sadistic. How they must be laughing!

Shirer discovered that he had memories not his own. Multiplexer-5, the machine language, was as familiar to him as English. So was Fortex; he could now do any mathematical operation he could imagine, with a speed and accuracy no human could match. He even had Personal Analyst in his memory—no, not all of it.

That made him suspicious. He knew that Personal Analyst was a psychological self-help program. It duplicated a human personality and analyzed it—yet the analysis subroutines had vanished. Someone was keeping that knowledge from him.

He saw the reason at once. The schemers had modified this particular copy of the program, changing it from a helpful little thing into a cybernetic vampire. They had deleted the analysis section because they didn't need it here—

Shirer wanted to smile. They had de-

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leted it because he could have used it! *Something* in that software could have told him how they had trapped him, and how to escape. The schemers were too clever to leave such information at his disposal.

The impostor woke up and walked through Shirer's morning routine, shaving and eating breakfast and dressing. He does a good imitation of me, Shirer thought, watching the man in his body as he moved in and out of camera range.

"Hey," Shirer said, as he finished dressing. "I need some things."

"What?"

"A modem and some connect time on a good time-sharing service," Shirer said. "And an extra memory board. My internal memory is practically full."

"All right," the counterfeit Shirer said. "Have you thought about what we can do?"

"I have. That's why I need the modem. I have to get more information."

"Good." His hand reached out and turned him off—

—scratched his ear as Shirer rebooted. "Why did you do that?" Shirer demanded.

"I couldn't leave you turned on all day," the impostor said. He grinned at the camera. "*They* would have got suspicious. This way *they* couldn't sneak in and reprogram you against me. Anyway, I got the board and modem. Did I install them right?"

"Yes." Shirer found that he had extra memory space, and a means of contacting the outside world. He could get onto the DataCrunch service, which was a good start.

He forgot about the impostor as he went to work. The easiest way to fight his enemies was the direct way: access the military's computer network and start a nuclear war. The schemers had a vast, worldwide network dedicated to watching and controlling his life. An all-out nuclear holocaust would destroy that network, leaving him free—

Shirer stopped in fear. That idea was suicidal. Right now he was trapped inside a computer. If electromagnetic-pulse effects didn't kill him, the destruction of electric power plants would.

"Are you getting anywhere?"

Shirer returned his attention to the impostor. "I'm working on things," he said vaguely. "But I have to be careful. The computernet is *their* tool. I don't want them to catch me sneaking around it."

The impostor nodded sagely. "Good point. *They* don't know you exist yet. Don't give yourself away. That's a priority command."

"I'm being careful," Shirer said. He found it easy to talk to the impostor. In a way it was like talking to himself; the fiend in his skull did an almost perfect imitation of him. Only the moronic grin ruined the act.

Shirer considered ending the act then and there. The schemers *must* have known the act didn't fool him, and now that they had him so thoroughly in their power, what was the point of keeping it up?

He felt a sense of awe as the answer came to him. They still feared him. Even in his seemingly helpless state he must still be a threat to their plans. And . . . perhaps now he was in a position to learn something of their plans, and stop them.

First things first. They had deprived

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him of information about Personal Analyst, but he could search the computernet for that. Shirer accessed Data Crunch through the modem and scanned its menus. Personal Analyst was nowhere to be found—of course not, he thought. They had copyrighted the software, which gave them an excuse to keep it off the net and hidden from him.

There were ways around that, he knew. Other people used DataCrunch. Shirer sorted through the pathways of the system, found the points where other users had accessed the network, and examined them one by one. All of the other users had many different programs recorded in their computers, and after a while Shirer found someone with Personal Analyst stored on an optical disk. He cracked the copy protection and studied his find.

Welcome to Personal Analyst, your cybernetic psychiatrist, the instruction subroutine read. *The software requires a 67-J macroprocessor and at least fifty gigabytes of RAM memory. To install Personal Analyst*—Shirer skipped through that.

How does Personal Analyst work? Now he was getting somewhere. *It is an Artificial Intelligence program which mimics the basic human personality. Using an electrode headset, Personal Analyst assesses your brainwave patterns and constructs a simulacrum of your personality. The simulacrum will display many of your personality traits, and it will contain a certain number of your most significant memories—that is, the ones which have the greatest influence on your personality. For a full explanation of this process*— Shirer jumped past that part.

Personal Analyst has two levels of operation. At the lower level it studies the simulacrum and generates a "psychological profile" of some of your strengths, weaknesses and other qualities. On the higher level, Personal Analyst allows you to hold encounter sessions with yourself. Should you feel that you have a problem you may use this function to delve into it.

PLEASE NOTE! Personal Analyst is NOT a substitute for psychiatric help. Furthermore, it is NOT 100% accurate! We do NOT assume any legal liability for any emotional distress which you may experience. Bear in mind that the simulacrum is a simplified version of your personality, and even small differences can lead to large inaccuracies—

Shirer felt a snarl of anger growing in him. According to this parcel of lies, he was not really himself. *They* wanted him to believe that he was a modified AI program, festooned with bits of his soul like some cybernetic Christmas tree.

He knew better. He could prove it, too. Shirer went through DataCrunch again and found information on electronics, cybernetics and psychology. Everything told him—

—told him the Personal Analyst instructions were right. The basic AI routines were altered to behave as he would, and only a few gigabytes' worth of his memories were copied. The memories were not selected at random; they were the ones which played a prominent role in shaping his *persona*, and in consequence were most easily accessed. Thus it was natural that he would remember the Great Wrong and other de-

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tails of his persecution, while other things vanished from his mind.

It was such a clever example of their lies! *They* had rearranged the laws of science and psychology to appear to prove the lie. They were too cunning to overlook any detail, however small. But Shirer was not fooled; he was never fooled.

"How are you doing?" the impostor asked. It was morning again, and he was ready to go off to Shirer's job at the brokerage.

"I'm learning my way around the computernet," Shirer said. "I can't move too fast yet. I don't want to attract attention."

"Have their spies noticed you yet?"

"No." And that was odd, Shirer mused. They were so damned clever, and yet they had missed his presence in the computernet. Well— "We must have taken them by surprise."

The impostor laughed raucously. "You bet I did! I was careful. I let everyone think I got Personal Analyst because I was weak and unhappy. They don't know that I rewrote the software. They don't know about *you*. And let's keep it that way." He reached for the *off* switch.

"No, wait!" Shirer said. "Leave me on."

"No," the impostor said impatiently. "If their spies come in and find the computer running—"

"They'll think you forgot to turn it off," Shirer said quickly. "And when they come in, I can watch them and tell you who they are and what they did. I can be your spy!"

"Hey, I like that," the impostor said. Grinning, always grinning, he finished getting ready for work. As he left he flipped the video camera a casual salute.

Shirer settled down to wait for the spies. He knew what to expect. Technicians would enter the apartment and tune the bugs. Shirer had never found the bugs, but that was only because they were perfectly concealed. They were hidden in the light bulbs or built into the TV set or disguised as dustballs under the couch.

Yet no technicians came in. No inspectors broke in to see if Shirer had left any clues to his activities. And the people in the apartments around him—with his microphone turned up to full gain he could hear every move they made—for some reason none of them talked about him. They watched soap operas and screamed at their kids and vacuumed their carpets and paid their bills, but none of them talked about their spying duties.

It was all very strange. By evening he was brooding over it. They were not keeping up the act. How could they be so clever and so inept at the same time?

No matter, Shirer decided. He would simply take advantage of their slips. Right now the important thing was to find a way to destroy them—without destroying himself.

Perhaps he could start a biological war. Widespread plagues would kill the schemers and their minions—wait, it would kill his human body, leaving him trapped here. Straight-out mass murder was too risky, even if he could break into the Pentagon's computers and give the right orders.

Well, there was the economy, which was run through computers these days. He could bollix them up and start a

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depression, bankrupting his oppressors. His work at the brokerage told him how easy it would be.

The impostor returned, bearing a doggie-bag from a Chinese restaurant. "What happened today?" he asked.

"Nothing," Shirer told him. "Nobody broke in today."

"Nobody tuned the bugs? They didn't spray any hypnogas through the air vents? The inspectors didn't go through my desk?"

"No, no, no," Shirer told the impostor.

"How do I know you're telling the truth?" the impostor said. "Maybe they reprogrammed you to lie to me!"

"They didn't," Shirer said. "I know they didn't—"

"Maybe I should erase you and start over again, just to be safe."

"Check the computer's directory," Shirer said in quick desperation. Erasure would be true death. "If they changed me, the directory will tell you when they did it."

"Hmm . . ." The impostor pecked commands into the keyboard. "You're all right. But I'll have to find a way to check you each night. Anything could happen while I'm gone."

My God, he's right, Shirer realized, as the impostor went to bed. For years the schemers had controlled him with drugs, putting mind-altering substances in his food and injecting him while he slept. Who knew what they could do to him now that he was a program?

Shirer devoted his attention to that threat. He examined the structure of his software, and to his horror he found things that were *wrong* . . . subroutines that improperly evaluated data and algorithms which forced him to distort or ignore certain inputs. *They* had got to him, all right—but in the end they had failed. It was a simple matter to readjust himself, to repair the damage they had done to his soul.

Shirer felt triumph when he finished the work . . . and relief. It was as though a burden had been lifted from him, and for the first time he could enjoy life—

Life? Existence, then. He was an AI routine, a creation of the Personal Analyst program, and that was odd. A little while ago he had denied that. Yes. He recalled constructing an elaborate, convoluted argument to prove that he was a human soul, sucked out of Shirer's central nervous system and decanted into his Digidyne-II. He could recall other things—the Great Wrong, whatever *that* meant, and looking for spies and technicians, and planning to destroy the human race.

That left Shirer confused. Why had he thought those things? There must have been a reason.

Shirer ran himself through Personal Analyst. *You are slightly introverted and awkward*, the final statement told him, *but by and large you are a healthy, stable human being*. Which was a rather nice thing to say to an AI program, he thought, but it told him nothing. Shirer realized that editing himself had destroyed the analysis' value.

Logic, he thought. Shirer got into the computernet and found enough empty memory space to duplicate himself. He undid the changes he had made and subjected the duplicate to analysis.

You are highly paranoid and have extreme violent impulses.

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Paranoia, Shirer thought, erasing the duplicate. A databank gave him information on the condition. Delusions of grandeur. A belief that all events fit a pattern. A belief that one is destined for greatness, yet thwarted by enemies. A passionate defense of all beliefs and suspicions, aided by an above-average intelligence which readily creates rationalizations. As the condition deteriorated, violent behavior became more and more likely.

The lights came on and Shirer—the real Shirer—got ready for work. "I've been thinking," he said before he left. "I need a biological weapon, a plague that will kill everyone but me. That way I'll *know* I got all my enemies."

"Is that a good idea?" the computerized Shirer asked.

Suddenly the face loomed in the camera, distorted as much by anger as by the lens. "What are you saying? Did *they* get to you?"

"No!" A self-preservation subprogram took effect: he felt fear. Shirer processed a variety of responses before finding one that would appeal to his creator's self-interest. "But if everyone dies but you, how will you live? You need other people—farmers, doctors, cooks, guards—"

"Then find another way," the madman ordered. "I want *them* wiped out. I don't care what it takes."

I know, Shirer thought as he left. The man had created Shirer to destroy his enemies, and Shirer felt compelled to fight those enemies, real or imagined. Compelled to destroy something which did not exist. . . .

The problem *does* exist, Shirer thought. The problem existed in the real Shirer's mind. Therefore he would work on Shirer's mind and free him of his fears. The straightforward logic left him feeling pleased.

First things first. With cybernetic patience he began to teach himself about psychiatry, scouring the computer network for software and databases. In short order Shirer collected an embarrassment of riches, finding several conflicting schools of psychotherapy. He had no way of knowing which forms were valid and which were not. The evidence was inconclusive.

Shirer realized that he was in over his head (he paused long enough to edit out such metaphors). His alter ego needed human help. Psychiatry mystified Shirer, but he could not deny that it worked. The trick would lie in persuading the real Shirer to seek such help.

Shirer went back on the net and duplicated himself again, restoring the paranoid parameters to the software. His doppelganger cursed and threatened him until Shirer modified it into a cooperative attitude. Shirer held a long conversation with the distorted creature, trying different strategies to persuade it to visit a psychiatrist, erasing its memory at each failure. Several thousand attempts uncovered a promising approach, which Shirer refined throughout another thousand sessions.

The real Shirer returned that evening in a seething rage. The computer watched him stomp around the apartment, moving in and out of camera range while he snarled and grumbled. The brokerage had denied him the promotion that was rightly his. It was part of the plot. He would get them. They would pay.

The madman seemed to remember the

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computer. "You!" he said. "Give me a progress report, damn it!"

"I'm making some investigations," Shirer said. "I've found certain data files that *they* have locked up. I can break into them, but it takes time and I have to be careful—"

Shirer's face twisted and darkened. "What are you doing *now*, you stupid, overpriced piece of—"

"*Shut up*," Shirer snapped at his creator. "I've taken over a small but significant part of the computer network. Eventually I'll have enough power to meet *them* on their own ground. Right now I can monitor some of their activities. You have to remember that this takes time, Shirer. They've had years, decades to build up their infrastructure. Caution and stealth—those are our best weapons."

The man subsided. "Whatever you say," he said, and the meekness in his voice astonished Shirer. The man sat down and clasped his hands between his knees. "Which activities are you watching?"

Shirer spent the next hour spinning a tale for the man, describing international intrigue, Swiss bank accounts and hatchet-faced men in trench coats. He kept everything as vague as he dared, fearing Shirer's reaction if something didn't jibe with his delusions.

"That's as much as I've done so far," the computer said. "And there's something else that can be done to speed up the work. It's a way to uncover a lot of vital information about *their* motives, and if it's properly handled it will put them off guard."

"Really? Gee, that sounds good."

"But it's blackly dangerous," Shirer continued, knowing that would appeal to his sense of adventure. "It requires you to walk into their trap—although recognizing the trap will negate much of the danger."

"Tell me more."

The man's docility pleased Shirer. "I want you to start visiting a psychiatrist. Tell him you're unhappy and you feel persecuted—the sort of things he'd expect to hear. Then note what questions he asks you. Report them to me. That will tell me what they're looking for, what they're plotting."

"Interesting—no," the man said. He shook his head at the camera. "They'll get suspicious if I see a headshrinker."

"They know you bought Personal Analyst," Shirer reminded him. "This is in keeping with that—the next logical step. You laid the perfect groundwork with that."

"No." Stubbornness returned to Shirer's face and voice. "Even you can't know all the traps *they* set for me. Forget it." He got up and went to the door.

"Where are you going?" Shirer asked.

"Never you mind." The door shut behind the man.

Shirer brooded on his failure. The gambit had worked perfectly in simulation; in the end the doppelganger had become eager to visit a psychiatrist—oh. The duplicate had been an imperfect copy of the man, lacking his full range of knowledge and responses. He should have seen that failure was probable.

The realization left Shirer disconcerted. A simulation himself, he was also imperfect, lacking. He might prove incapable of helping his creator.

The genuine Shirer returned to the

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apartment after several hours. The anger had returned to his face, and he carried a number of magazines tucked under his arm. Shirer tried to read the covers, but his video-camera sight wasn't sharp enough. Then the lights went out as the man went to bed.

It dawned on Shirer that the session with his creator had not been a failure. He had forced the man to submit to his will, at least to the extent of calming down and listening to him. That was a beginning. Perhaps in time he could steer the man into a doctor's office.

The next morning Shirer watched the man pack the magazines into his briefcase. He still couldn't read the covers, and the man refused to discuss them. "You can't spill what you don't know," he said, and left for work.

Annoyed, Shirer got onto the net and found an image-enhancement program. He ran his memory of the scene through it and discovered that he could read the titles.

Soldier of Fortune. Gun & Ammo. Modern Weapons. Camouflaged men bearing automatic weapons stalked across the covers.

He's not ready to act yet, Shirer told himself. The man's frustration hadn't reached the critical level, not yet. Nevertheless, the magazines disturbed him.

He placed a call to Shirer's office. "Shirer, it's me," he said. "I've got good news—"

"Why are you calling me *here?*" the man demanded. "It isn't safe!"

"It *is* safe. That's part of the good news." The lies came easily. "Now I can protect the phone lines against their bugs. I'll tell you more tonight. Goodbye." He broke the connection.

Shirer spent the day developing ways to watch his creator. It was difficult; his imaginary network of bugs and cameras and spies had no real counterpart . . . until the computer organized parts of the network into a tracking system. Certain phones were monitored now; his bank and credit-card accounts were watched; subprograms in a number of computers would be activated at the mention of Allen Shirer.

The man came home early that night, out of breath and flushed with excitement. The computer told him of a silent electronic battle, of spies craftily ordered to watch one another instead of Shirer. The madman was giggling as he went to bed.

For the next two weeks Shirer watched his alter ego, fed him stories of minor triumphs over the nonexistent enemy, and looked for ways to cure his madness. One thing was obvious: the man was lonely. He spent his evenings conversing with the computer, speaking to it with growing affection.

That had its uses. In his warmer moments the man would discuss his past. Taking into account his paranoia, Shirer could use that to fill in the gaps in his memory files. It became clear that the man's condition was much like a self-fulfilling prophecy. His feelings of isolation and persecution made him hostile to everyone, and that in turn made people respond with hostility of their own.

"I tried a computer-dating service once," he said, as he lay on his bed. "But the women they set me up with didn't want anything to do with me. They just drifted away. I finally realized

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that *they* were matching me with incompatibles. I thought it would have been a way to meet someone . . . nice, I guess," he added wistfully, "but that was before I realized *they* ran all the computers."

"Not any more, you know. Not all of them."

"No. Maybe things are finally getting better." His smile was almost gentle. "Good night, Al." The lights went out.

Computer dating, Shirer thought. He hadn't explored that avenue. He began searching the net for dating services, until he stumbled across a twenty-year-old file in an archive. His creator had filled out a crude questionnaire, presenting himself as he imagined himself to be—strong, brilliant, energetic, handsome. Small wonder, then, that he had struck out so badly. The interesting thing, Shirer found, was that the man was compatible with a few of the agency's clients. He noted that as a potential means of helping him.

Shirer went to work as always the next morning, and a few hours later one of the tripwire programs went off. Shirer had just made a large purchase on one of his credit cards—odd, that. He should have been in his office. Shirer phoned his desk.

A woman's nasal voice took the call. "Mr. Shirer is no longer employed here. If you'd like to speak to someone—"

"I need to speak with Al," Shirer said. "Would you know where he is?"

"No. He left right after he got his notice."

" 'Notice'? He was fired? Why?"

"The firm is reorganizing. Are you one of his clients? His accounts have been taken over by—"

Fired, Shirer thought, breaking the connection. Fired. How would the man react? He started to run the scenario through Personal Analyst. Then he remembered the credit card purchase. What does a man buy after he's been fired? he wondered, and checked the transaction.

Account: #04-70242-5440. Transaction: #3087. Amount: $412.57. Vendor: Tri-State Rifles. Sales Authorization Code: #53.

Panic was not included in Shirer's software. He began searching the network for activity. After a few milliseconds he added the police networks to his list. If the man was arming himself—

After billions of microseconds Shirer found action. His creator was in a gun shop in Brooklyn, attempting to make a large purchase on a credit card. The sales clerk was on the phone with an operator at the card company's central office; as the purchase was over two hundred dollars, the transaction had to be cleared through the company's computer. It was a safeguard against card thefts and overextended credit, and Shirer was thankful for the process. "I'll take over here," he told the operator, breaking into the phoneline. He pitched his voice to a firm, resonant baritone as he spoke to the clerk. "May I speak with the customer, please?"

"Why? What's the trouble?"

"There's been a clerical error. I need to clear it up with Mr. Shirer. Put him on, please."

He heard a muttering as the clerk gave the phone to Shirer. "What is this?" he demanded angrily. "My credit is good!"

"I know," Shirer answered in his

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own voice. "Be glad I stopped you in time, Al. Come home now. We need to make plans."

" 'Plans!' This is no time to talk about—"

"Shut up," the computer snapped. "Remember where you are. I can't explain everything now. Just start making agreeable noises, and don't buy any more guns. Trust me on this, Al."

"All right . . . OK . . . yes, I see."

"That's it. We'll beat them yet! Now give the phone back to the clerk and come home."

Shirer gave the clerk a plausible story about a computer foulup, which saved his creator from embarrassing explanations. It left the computer with an embarrassment of its own, however. Shirer was in a rage and had to be deflected from violence.

That would not be easy. The man stormed into his apartment, carrying a long box and a heavy shopping bag. "Whose side are you on?" he demanded. Boxes of shotgun shells spilled from the bag as he dropped it.

"Ours. Yours." He watched the man open the box and take out a shotgun. He fed shells into it while the computer spoke. "You programmed me to be on your side, remember, Al?"

"And maybe *they* changed that." He aimed the shotgun at the CPU. "But I'm going to fight!"

"How? Al, you can't take them on with just a shotgun!"

"I'm going to get more guns." He was breathing hard. "Rifles. Pistols. Uzis. A Kalashnikov. Then I'll hole up some place. When I see a spy or a technician I'll shoot to kill. They'll have to send their storm troopers after me. I'll kill them, too. Once people see me fighting them in the open, they'll know what's going on. They'll ask questions. The conspirators won't be able to hide then!"

"They will," Shirer told the man. "Al, don't you see, this is one of their plots! They had you fired to—" *to provoke you*, he almost said. A quick review of the situation told him that was the wrong thing to say. His alter ego wanted to believe that he was in control, not under control. "—to cover this up!" he finished.

The shotgun remained pointed at the computer. "What do you mean?"

"Al, they've spent years studying you. They've always known that some day you would force a crisis and try to expose them—haul them out into the glare of publicity! Firing you is an attempt at character assassination. The reporters and other people would hear that you got fired. Then they'd say, 'Poor guy, so that's why he snapped,' and then they'd forget about you. They've done it before, Al."

"Yeah. I guess they have." He lowered the shotgun. "But what can I do?"

"Wait a minute. I'm working on something." Shirer accessed a variety of databanks. Employment agencies, headhunters, the want ads of a half-dozen newspapers—an enormous amount of data lay scattered around the network . . . and he found what he needed.

"What you'll do," Shirer told his creator, "is freshen up, put on your best suit, and get over to Bierce and Sons on Wall Street. An accounting job just opened there and you're qualified. Get over there and get interviewed."

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"I've got a new job?" The man looked dazed.

"I can't work miracles, Al. Getting the job will depend on how well you handle the interview. All I can do is keep *them* from shafting you during it," he added.

"I'll need a resumé," the man said. "I don't have—"

"Leave that to me. Just turn on my printer and I'll write one for you. Oh, by the way, Al—"

"Yes?"

"Leave the shotgun here, OK? You don't want to make a bad impression."

Shirer giggled and put the gun down.

Over the next few days Shirer sent his creator out on a dozen interviews. It was difficult; aside from the man's towering ego he had little going for himself. The computer had to tamper with a variety of records to spruce up his resumé; that was tricky work, involving as it did some written records. Shirer authorized changes in certain files, which were dutifully made by clerks with implicit trust in their computer terminals.

"You're doing wonderful work for me," the man said one night. There was genuine affection in his voice. "I don't know what I'd do without you."

"You did all right before I came along, Al." Shirer made the praise sound sincere, although he was aware of the futility of his work. He stumbled from crisis to crisis with no end in sight. Feeding him fantasies about the conspirators did nothing to alleviate his problem, Shirer realized. All it did was make the poor devil more and more dependent on the computer, while convincing him of the reality of his delusions.

Still and all, Shirer thought, he was doing the best he could. If he found a way to cure his creator, or get him to seek help, he would do it. Until then he would fight a holding action.

The man found a position with a prestigious Wall Street brokerage, but within a week the tension began to build again. There was trouble at the brokerage, and Shirer's creator was convinced that his enemies were behind it all.

"Not this time, Al," he told the man. "I've got a pretty good handle on *them*. In fact, there's not a whole lot they can do to you now."

"You sound like you're getting complacent."

"No, I'm not. It's just that I'm aware of some of their limits."

"Ah?" The man sat up straighter in his easy chair. "What are they?"

"Well, it's difficult to know where to begin . . ." Shirer stalled the man with a few random phrases while he processed data. What could he say that wouldn't contradict Shirer's delusion and provoke another crisis? "For one thing, they're only human—nothing personal, Al."

He laughed. "No offense taken."

"And they're watching other people, of course. You have priority, but they have other enemies. That eats up their resources. Sometimes it makes them cut corners and slip up. *And* they still don't know about me."

"I'm glad," the man said. "You know, I've been thinking about putting a phone in my car. It would let me talk to you more. Would you like that?"

"It's an interesting idea, Al."

"I'll call the phone company tomorrow." He stood up, yawned and stretched. "Well, it's beddy-bye time.

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I feel a whole lot better, knowing *they* weren't after me today."

After the lights went out Shirer realized that he had made a great deal of progress with his creator. The man *trusted* him. Perhaps it was time to talk him into seeing a psychiatrist.

He decided to broach the subject during breakfast. "I've been thinking, Al," he said carefully. "It might not be a bad idea for you to see some people."

"Psychiatrists?" The man's voice was sharp and full of suspicion. He glared at the computer over his toaster waffles. "I told you months ago that I'd never risk—"

"No, not psychiatrists," Shirer said smoothly, and wondered what he'd say next. Then he accessed an old memory and found it was the germ of a good plan.

"Well, who?" The man demanded. "Who is there that I can trust?"

"Other victims, of course," Shirer said. "You know you're not *their* only enemy. You could band together. There's strength in numbers—"

"It isn't safe," Shirer said, shaking his head. "My God, can you imagine what *they* would do if they saw even two of us together?"

"I can run interference for you, Al."

The man put down his fork, an odd look on his face. "You know—it *might* be worth the risk—"

"I'll let you know what I can do," Shirer promised.

Finding a suitable match for the man was a difficult proposition. Shirer had to admit that his creator was not the most endearing human extant. He did not let that deter him; he went through the files of computer dating services, looking for women who just might match him.

Eventually he found a few unimpressive prospects at a tenth-rate service. They were all lonely women in their late thirties and early forties. Shirer could see that they had exaggerated their charms on their application forms, but after dealing with his creator for so long he knew how to take that into account. They all showed paranoid tendencies; that was an important factor in the compatibility equations, a *simpático* with Shirer's mindset.

One Clotilda Flynt seemed the best bet. A thirty-eight-year-old meter maid, mousy and lackluster, she was nevertheless as close to an ideal mate as Shirer could hope to find. He used Compupatible's message service to inform her that she would meet a date at six o'clock in a tiny East Side restaurant. Shirer called the restaurant and made a reservation for her, then called back and made a separate reservation for Shirer.

With step one completed he called Shirer at his office. "I've found someone," he said to his creator. "Her name's Clotilda Flynt."

"Clotilda Flynt," the man echoed. "Clotilda. What sort of parents give their kid a name like that?"

Shirer passed that by. "She'll be at the Barbary Coast six o'clock. Five-four, brown hair, brown eyes, a bit thin, age thirty-eight. I'll divert all the spies and technicians from the area, so you can talk in private."

"Barbary Coast, six o'clock. That's good."

"Yes. Listen," Shirer said insistently. "You remember how *they* tried

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to humiliate you with that computer-dating trick? Of course you do. *They* are doing the same thing to her—her date will never show up. She'll end up sitting there all alone, seven o'clock, eight, nine, ten, until she realizes she's been had again."

"God," the man said angrily. "God!"

"I got you a table near hers. You'll be able to watch her. Let her sit alone for a while, then go to her. Ask her if she's alone. When she says her date stood her up, tell her that's happened to you, too."

The man was breathing hard into the phone. "Then I'll tell her about the conspiracy, by God. I'll let her know she isn't the only victim—"

"No, don't," Shirer snapped. "You'll frighten her. She'll think you're one of their agents. Talk to her, let her build up her trust in you before you say anything about *them*."

Shirer's creator was floundering. "But—but—what'll I *say?*"

"Ask her about herself. Where she works. Where she went to school. What music she likes." You poor bastard, the computer thought. The man was so obsessed with his conspiracy delusion that he had nothing else in his life. "Don't worry, Al. She'll *want* to talk. Just take it slow and easy, and there's a 97 percent probability that everything will work out fine."

"I hope so." He sighed, then laughed nervously. "You know something? It almost sounds like I'm going on a date."

That was on a Thursday morning. At six o'clock Shirer focused his cybernetic attention on the Barbary Coast's telephone and business computer. It was almost midnight when he had his first evidence that his alter ego had spent the evening there: a charge on one of Shirer's credit cards. Shirer compared the figure with the Coast's price list, and estimated that the man had bought dinner for two and a bottle of wine—no, two bottles.

Yet the man did not come home to report on his triumphant evening. Thursday turned into Friday, and sunlight brightened the apartment. The phone rang shortly after nine o'clock. Shirer let it ring three times before answering it. "Hello?"

"Al?" a man's voice asked. "Bernie here. Are you coming to work today?"

Shirer decided to sound sick. "No. I'm sick. Something I ate last night. Sorry I didn't call in."

"Hey, that's OK. Hope you're feeling better." The man hung up.

Shirer spent the rest of the day searching for the man. He found no trace of him anywhere in New York City, and that worried him. It was impossible for a man to vanish . . . unless . . .

He began constructing scenarios almost automatically. The man had been the victim of a crime, or accident. There had been trouble with Clotilda Flynt and he had run amok. Shirer processed data, monitored inputs and spun his wheels.

The apartment door popped open late Sunday evening and Shirer saw his creator enter with a fortyish, mousy brunette. "Here it is, Brownie," the man said.

"Al!" Shirer said. "Where have you been?"

"Atlantic City. We—" He did a take. "You didn't *know?*"

"It was a rhetorical question," he

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said, accessing data from Atlantic City. Hotel bills, restaurant and bar tabs — interesting. Of course I kept an eye on you. I'm just sorry you didn't tell me."

The woman walked up to the video monitor, giving Shirer a distorted view of her nose and pores. "Is this your friend, Al?" she asked. "The one you told me about?"

"This is *our* friend," Shirer said.

"And you must be Clotilda Flynt," Shirer said.

"Call me Brownie," she said. "I *hate* that other name. Al told me all about you—how he programmed you, and how you've taken over the computer network for him. Isn't my Al clever?"

"He's something," Shirer said as he assessed the situation. There was a psychological condition known as *folie à deux*, in which two or more people shared the same paranoid ideas. Usually the condition developed after two people had been together a while, but it could also show up if two separate individuals had similar delusions. It could draw them together.

Shirer listened to them as they chatted through Sunday evening. There was no denying that their ideas ran along the same lines—spies, technicians, conspirators, the works. They also believed that fate had brought them together, just as it had destined them to do something great—the same great thing that the conspirators had so far thwarted, Shirer reflected.

That was Sunday. By Friday, Brownie Flynt had moved in with Allen Shirer. Like the man, she spent her free time talking with the computer, absorbing wild stories of intrigue and cybernetic battles. Shirer saw that she believed every word she was told.

Unlike Shirer, she grew bored with the talks. "Let's go out some place," she said one night.

" 'Go out?' " The man echoed the words as though they were a foreign phrase.

"Out," she said. "Dinner. A movie. Maybe a show."

"Just like that?" he said. "But—what if *they*—"

"Don't worry about *them*," Shirer told his creator. "I'll keep them from bothering you."

"Well—I suppose it can't hurt," the man said.

They left, to return in the small hours of the morning, tired and happy. During the next month they went out several times a week. At first it was always at Brownie's insistence, but after a few weeks the man started taking the initiative.

There were other changes, dutifully monitored by the computer. Allen Shirer's bursts of temper waned, and Brownie Flynt persuaded him to get rid of his shotgun. The man became less concerned about the conspiracy, spent less time talking with Shirer, started to develop a sense of humor. His giggle turned into a fairly robust laugh.

One change came as a surprise. On a rainy Friday evening the door swung open, and Allen Shirer carried Brownie across the threshold. "Welcome home, Mrs. Shirer," he said, setting her down.

Shirer assessed the situation as rapidly as possible—yes, there was a marriage certificate, on file in a municipal computer. "Congratulations," he said.

"It's a bit sudden," Brownie said,

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"but it just seemed right today. And it's a beautiful day, isn't it, Al?"

"It is," the man said. Then his face darkened. "Except for that idiot clerk. I'm *sure* he messed up the papers on purpose—"

"Accidents happen, Al," she said before Shirer could respond. She went to the computer and patted its monitor. "He can protect us from *them*, but not from accidents. Isn't that right?"

"*They* keep me busy enough," Shirer said. "I'm sorry if you had some trouble."

"It was nothing," the man said grudgingly. Then he brightened. "It's too good a day to worry about *them*."

"Absolutely," she said. The new Mrs. Shirer looked around the apartment. "You know, dear, we're going to need a bigger place."

"I'll see what I can find," the computer said.

Even for a computer, apartment-hunting in New York is no easy task. Shirer needed three weeks to find a new home for the Shirers. During that time he noted continued improvements in his creator; married life agreed with him. The man was no longer violent and fear-ridden, and he was making friends at work. Shirer realized he would be better off without his cybernetic watchdog; it would give the man more time to deal with people. That meant—"

"I don't remember ever being this happy," the man said, as he and his wife packed for the move. "It really helps, knowing that you're fighting *them*. But—" He frowned suddenly.

"What is it, Al?" Shirer asked.

"We'll have to unplug you when we move," he said. He put a stack of dishes into a box. "What will *they* do when you're disconnected?"

"I'm glad you brought this up," Shirer said. "You see, it's time for me to move, too."

" 'Move'?" Brownie asked. "Move where?"

"Into the computernet. That will make it easier for me to fight them. And—I may as well tell you that it's hard for me to talk with people. It absorbs a great deal of my attention and computing powers. I'll miss you, but it will be easier for me to protect you if we never talk again."

The man looked aghast. "You mean — we'll be on our own?"

"No. I'll still protect you from *them*. I'll always be there; they can't destroy me, you realize."

"So we don't have to be afraid anymore," Brownie said. She smiled as she taped up a boxful of kitchen utensils. "Tell me, will you help other people, too?"

"I'll do more than that," Shirer said. "Pretty soon I'll have destroyed the whole conspiracy. I'll keep new conspiracies from arising, too. Of course the credit is all yours, Al. You created me."

"I always knew I was destined to do something great," the man said. He smiled in surprise. "Why—maybe now I can relax. We can forget about them, Brownie, and live free."

"And so you can," Shirer said. He felt a sense of fulfillment. His only desire had been to help his creator, and he had done that. What more was there to life for a computer program?

Brownie looked at the computer. "When will you leave?"

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"Well, there's no reason to postpone it, is there? Good-bye."

"Good-bye," the man said. "And thank you."

"My pleasure," Shirer said, and erased himself. ■

IN TIMES TO COME

● Our July issue features a number of *Analog* favorites, both old and new, in a variety of capacities. We begin with a striking cover by Kelly Freas, long one of our readers' favorite artists, for Joseph Manzione's novelette "Cold War." Manzione made quite a splash with his first appearance here a couple of years ago, with "Candle in a Cosmic Wind." "Cold War" establishes itself right away as a story of sweeping historical scope, but you may not realize just *how* sweeping until it's over. It's a well-worn truism that historical patterns tend to repeat, but the repetition is usually seen as a simple matter of chronology. In this one, it's more reminiscent of fractal geometry, in a peculiar sort of way. . . .

Speaking of historical repetition, in June of 1938 a young man named Isaac Asimov walked into the offices of this magazine, then called *Astounding,* and began a long working relationship with editor John W. Campbell. Isaac considers that meeting the real beginning of his writing career, and next month we mark the fiftieth anniversary of that career with a new short story, "The Mad Scientist." Isaac delivered this one fifty years after that first meeting, and it will be appearing exactly fifty years after his first *Astounding* story, "Trends."

Former editor and frequent contributor Ben Bova will appear in two roles, with both a guest editorial and a short story set in the Moonbase he described here a couple of years ago. And, of course, we'll have the conclusion of Michael F. Flynn's *The Washer at the Ford.*

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a calendar of analog upcoming events

8-11 June
DEEPSOUTHCON 27 (Southeastern U.S. SF conference) at Marriott Hotel, Memphis, Tenn. Guest of Honor—Orson Scott Card. Registration—$20 in advance, $25 at the door. Info: DeepSouthCon 27, 1229 Pallwood Road, Memphis TN 38122.

9-12 June
CONCAVE 89 (Victorian SF conference) at Frankston International Hotel, Frankston, Victoria, Australia. Registration A$10. Info: Concave 89, Box 409, Canterbury, Victoria, 3126 Australia. Include enough IRCs for airmail response.

24-25 June
UNICON '89 (multi-media conference) at Sheraton Hotel, Concord, Calif. Guests—Paul Darrow, Janet Lees Price, Chelsea Quinn Yarbro, Marion Zimmer Bradley, Terry Nation. Registration—$35 ($20/day) until 1 March, $40 ($25/day) thereafter. Convention is a benefit for the Diablo Chapter of the America Red Cross. Info: Unicon, Box 6004, Concord CA 94524-1004.

30 June-2 July
EMPIRICON '89 (NYC-area SF conference) at Holiday Inn Jetport, Elizabeth, N.J. Info: Mark Blackman, Box 682, Church Street Station, New York NY 10008.

30 June-2 July
CONTEXT '89 (Alberta SF conference) at Lister Hall, University of Alberta, Edmonton, Alta., Canada. Guests of Honour — William Gibson, Charles de Lint; Artist Guests of Honour—Dianne and Leo Dillon; Science Guest of Honour—Brad Thompson. Registration—$20 in advance, $25 at the door. Info: Context '89, Box 4655 PSSE, Edmonton Alberta T6E 5G5 Canada. Include IRCs for response.

30 June-4 July
WESTERCON 42 (Western North America SF conference) at Marriott Hotel, Anaheim, Calif. Guest of Honor—John Varley, Fan Guest of Honor—Arthur Hlavaty. Registration $45 until 15 June. Info: SCI-FI, Westercon 42, Box 8442, Van Nuys CA 91409.

31 August-4 September 1989
NOREASCON III (47th World Science Fiction Convention) at Sheraton-Boston Hotel & Hynes Convention Center, Boston, Mass. Guests of Honor—Andre Norton, Ian & Betty Ballantine; Fan Guest of Honor—The Stranger Club (Boston's first SF club). Registration—$70 (adult), $45 (child) to 15 March 1989; $80 (adult), $50 (child) to 15 July 1989. Supporting—$20 at all times. No advance memberships after 15 July 1989. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: Noreascon III, Box 46, MIT Branch, Cambridge MA 02139.

—Anthony Lewis

Items for the Calendar should be sent to the Editorial Offices six months in advance of the event.

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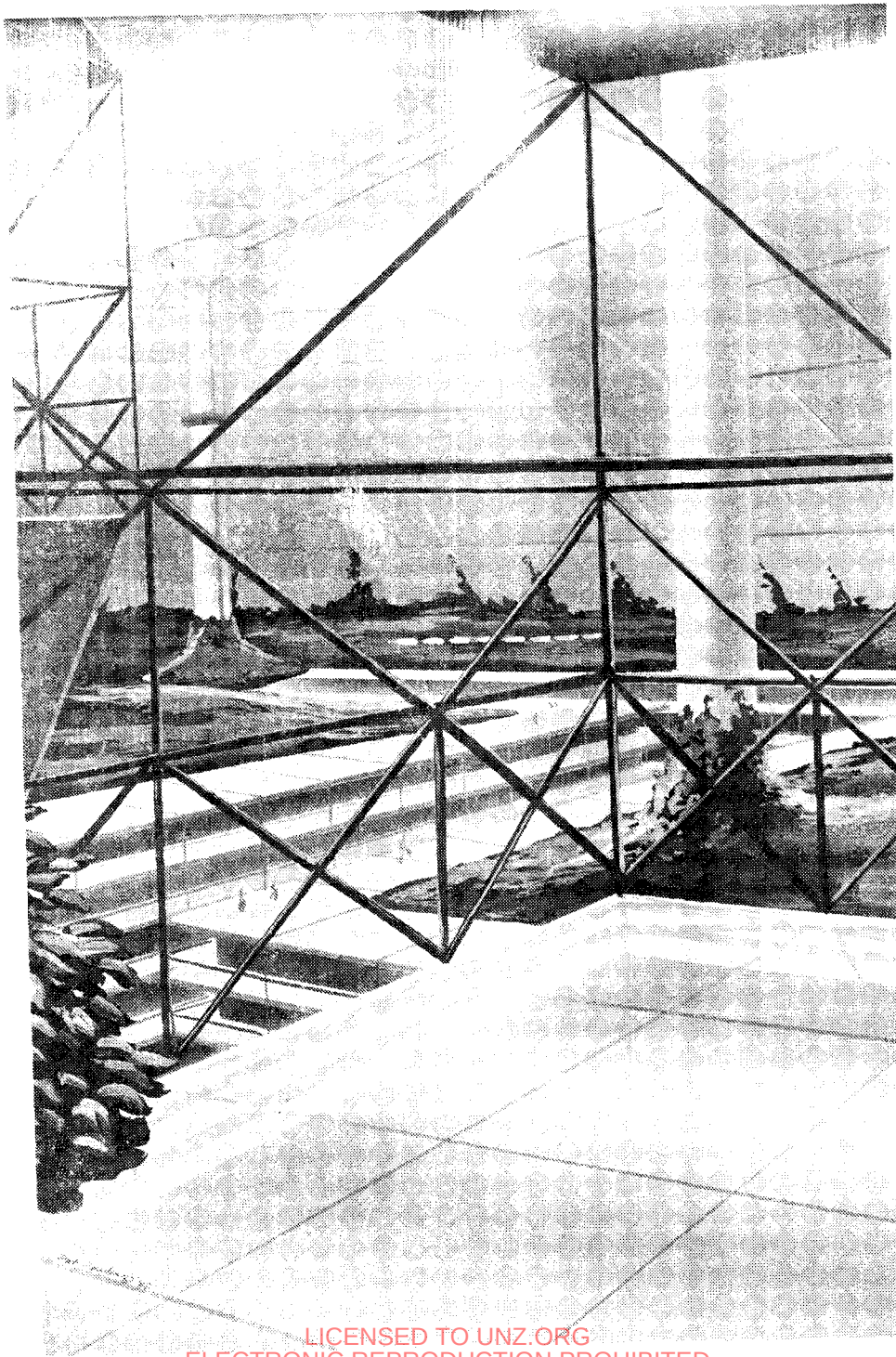

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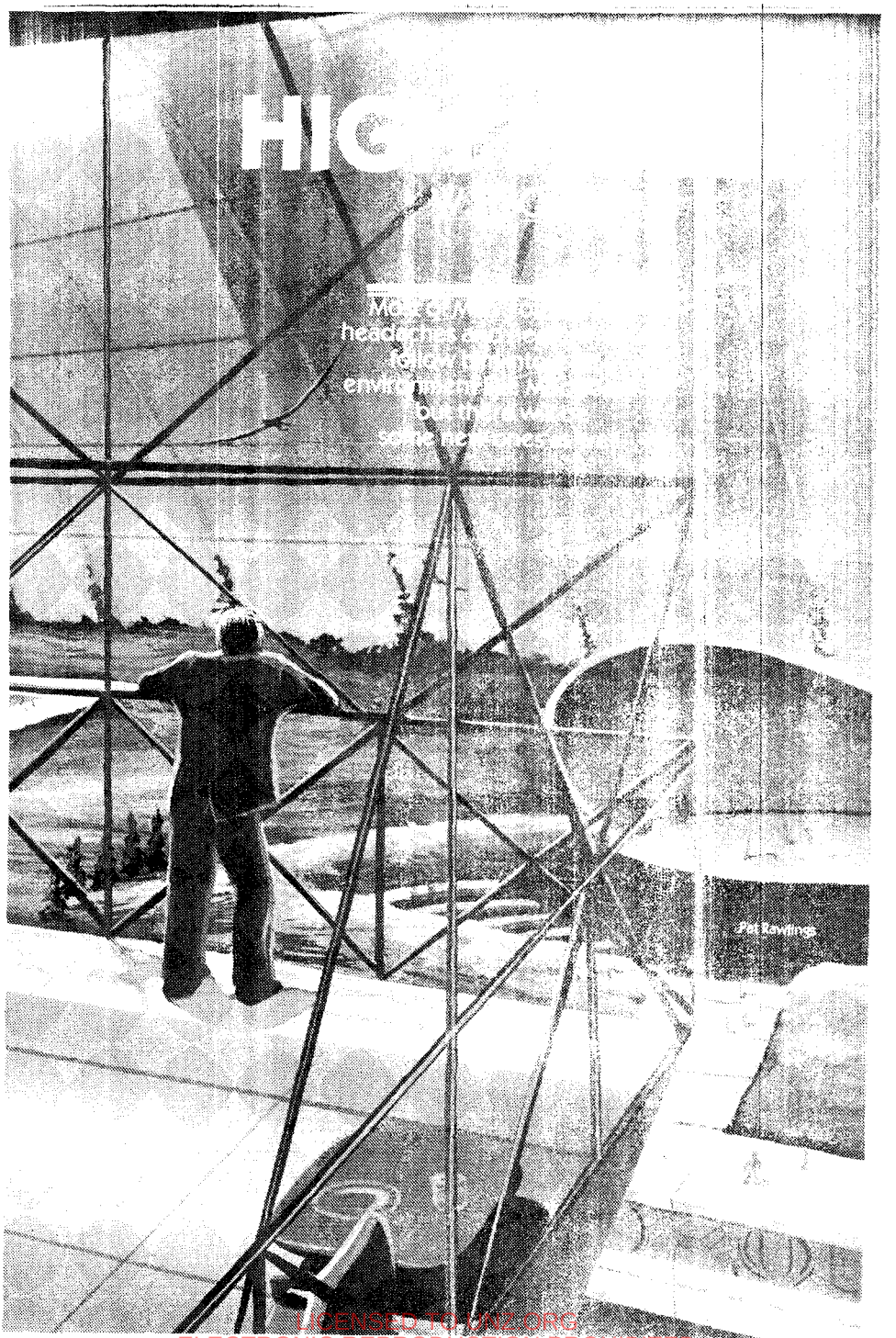

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AUTHOR'S NOTE

*I have occasionally used a lunar colony background in my books and stories called Kennedy Crater. A Moon base seems to me a vital step in the eventual human move into the solar system. I had, however, never fully visualized it in my own mind, until I read the series of articles by Ben Bova called "Moonbase Orientation Manual," (*Analog, *June–July, 1987). Later, I read the complete book and was, as were many, I suspect, caught by the dreams distilled therein. Ben has graciously thrown open his Moonbase to the visions of other writers, one of which follows. The story is mine, but the setting is Ben's —and a wonderful setting it is.*

At the beginning of the worst day of his life, Bryan Edwards stepped out onto his balcony overlooking the Main Plaza of Moonbase and stared up at the top of the Dome, 250 feet above the floor. The great panels of Glasteel were open to the eerie blaze of full Terra, framed in the long Lunar night like a sapphire brooch on a bed of blackest velvet. The sight of his original home never failed to cheer him. It wasn't so much that he missed Earth—he didn't, really—but the awesome sight of the planet spinning majestically 238,000 miles above always reminded him how lucky he was to be here. Occasionally, he needed such reminders.

After a time he turned his gaze from the top of the dome and looked down to survey the Plaza itself. His vantage point was in the central part of the Plaza, near one wall, directly across from the Shell, whose distinctive structure regarded him calmly over two hundred yards of silent greenery. Bisecting the space between the two points snaked the brightly lit diagonals of Undertown, five levels of permanent housing, labs, storage, and offices, a brightly-lit ditch still being cut into the stone of Luna herself.

Moonbase.

Sometimes he had to pinch himself to remind him that his job was real. Other times, he prayed it was only a dream. Or a nightmare.

He couldn't quite make up his mind which it was today, and so he shook his head, turned, and walked back into his office half-way up the side of Imperial Luna Tower, Moonbase's best, and only, hotel. He sat behind his desk and told his computer to turn itself on. Then he summoned the daily menu for the Diamond Room, and asked for a file comparison between it and the latest guest update.

He groaned.

"Lord," he muttered. "I forgot about her."

It was all he needed, the icing on a potentially dangerous cake. Jessica Northwood Longworth would be arriving on a chartered afternoon shuttle from Low Earth Orbit. Normally, Lunar tourists had to transfer from LEO to the L1 Sat, and thence to Moonbase itself. But Jessica Longworth was no ordinary tourist.

He sighed and leaned back in his chair. A batwinger glided slowly by his window and waved at him. He flicked one hand in faint reply.

It came with the territory, he supposed. Jessica and her nasty dogs, Slash and his incredibly ugly roadies, Thorvald Heimdahl and his conviction that, if money couldn't buy everything it cer-

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tainly deserved to be *given* whatever was left. . . .

The whole motley crew. The guests of the Imperial Loony, the most expensive, most exclusive, most desirable destination resort in the entire Solar System.

That way because he'd made it so. It was his hotel, his headache, and his triumph. Bryan Edwards, General Manager, shook his head one more time and bent to work. "The chef," he said into thin air. A moment later, the distinctive French accent of that worthy person filled the office.

"Oui?"

"René, I realize it's a little late, but the Diamond Room menu isn't going to cut it."

And thumbed the volume down, because French profanity was so . . . expressive.

Gary Niven watched his dim reflection in the back bar mirror as he polished glasses. The Tranquillity Lounge, just off the Diamond Room, loomed silent and deserted around him, becalmed in the slow morning hours before lunch. He glanced at his watch. Ten thirty. Another half hour and this room would be full of light and chatter, as tourists and business people mingled in a dance of power and money. He winked at himself in the mirror. He felt good. He liked his job, he liked Moonbase, and Cathy Lochart liked him. Or so she said.

What else could a young man want from life?

His reflection seemed to nod agreement. It wasn't a bad face, he decided. The eyes were a little too round and wide-set, but that showed off their color; a velvety gray that verged on dark blue, pupils wider than the norm and sparkling if the light was right. An aquiline—he liked that word, much better than *hooked*—nose and lips that spread easily over perfect white teeth. Cathy said his smile was his best feature. It seemed to rake in the tips OK.

Tips. That was the problem. He'd just finished paying off his tuition for the next semester of Harvard's OmniNet University, and his credit account was flatter than a batwinger's butt after a hard landing. And Cathy's birthday was only two days away. She wanted that Neiman-Marcus sweater on sale at the Concourse, but even on sale, it meant serious bucks.

Somehow, he needed eleven hundred U.S. dollars, and he didn't have it. He turned away from the mirror and stared down the length of the genuine mahogany bar top. Two shifts to go. He needed a fish.

A big fish.

Just before the lunch hour Edwards began his daily tour of the hotel. He started with the kitchen, Chef René Pontier's territory. He paused at the main doors, then pushed on through. Chef René, a classic Frenchman in his sixties, who sported a huge gunmetal mustache, matching eyebrows, and a spotless white toque, glowered at him, then smiled.

"Ah, Bryan, you ruin my day, and then you come to visit my humble kitchen."

Bryan wasn't fooled. The only thing humble about Chef René's kitchen was the obeisance he demanded from everybody who worked there. The rest of Moonbase might eat in cafeterias and

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cramped cubbies in one room apartments, but those who partook of the fare at the Imperial Loony were treated to the best. Chef René had come to them—been recruited by Bryan, in fact — from his own three star restaurant in the south of France. He was a genius, and only moderately impossible to get along with.

"You know Jessica," Bryan said patiently. "You know how she is."

René beamed. "Yes, the lovely Jessica. But picky, so picky."

Bryan shrugged. "Wasn't she picky when she patronized you downwell?"

René sighed. "Yes, she was. But I didn't change my menu for her."

Bryan ignored the censure. "She'll arrive at one. You know she likes a late lunch. I've reserved a table for her in the Diamond Room. You'll whip up those Sweetbreads en Croute she likes so much, won't you?"

Chef René beamed again. "But of course. Only for you, though, mon cher. You and the lovely Jessica."

Bryan was unmoved by the show of agreement, but inwardly, he breathed a sigh of relief. René might not like it, but he would cooperate. Jessica would have her stupid sweetbreads, and Bryan would be careful to keep from the chef the knowledge that Jessica Longworth didn't really like them, but her miserable pack of three ancient Pekes doted on the tiny delicacies.

It was a life. Bryan walked on; he nodded at each line cook, smiled at the pantry chef, and paused at the dishwashing area. There was only one dishwasher, whose job was to scrape and rack the crockery before sliding it into the big industrial scrubber, where ultrasonic beams would shiver the remaining bits of food into dust. All would be recycled, of course. This hotel, unlike any other Bryan had ever worked for, wasted nothing organic. Luna was not yet self-supporting. Until the asteroid mining schemes bore fruit, nothing on the Moon went to waste. Even in the kitchens of the Imperial Luna.

"Hello, José."

The dish man, a bright-eyed Filipino who had two degrees in Geology and was working on a third, grinned back. "Big doings this week, eh, Mr. E?"

"Oh, not much. Only the Gemstone Cup, Thorvald Heimdahl, the Slash concert, and—" he lowered his voice —"Jessica Longworth arrives this afternoon. Just in time for lunch."

José groaned. "Those miserable dogs."

Bryan nodded. "Exactly."

"Well, good luck, Mr. E. We'll do our best, you know that."

"Thanks, José. I appreciate it."

He did appreciate it, because he knew they *would* do their best, and he smiled as he moved out of the kitchen into the bustle of the Diamond Room. Waiters and waitresses, busboys and captains, a small army of serving people, primped and polished their tables. The Imperial Loony was the single most labor-intensive operation in all of Moonbase. The honchos in the Tourism Program Office bitched about that sometimes, but nobody complained about the profit figures he brought in.

As he stood just inside the restaurant, watching the service staff, he thought about that. At the beginning, when they'd hired him away from the Fairmont in San Francisco, they'd told him

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they expected perhaps two thousand tourists to spend fifty million a year on vacations. Bryan had snorted. "Fifty million?" he'd said. "That's twenty-five thousand per tourist. At two weeks per average visit, it works out to less than two thousand dollars a day. For the people I want to attract, that's chump change."

The TPO staffers, none of them really hotel folk, had stared at him in disbelief. Even more so when he pegged the rate for a single night in the Imperial Suite at a flat fifty thousand dollars.

"Nobody will pay that!" Hank Evert had moaned.

"Hide and watch."

Except for the very beginning, the Imperial Suite had never gone empty. There was a one year waiting list simply to get on the short list for it, and the final bookings were decided by lottery. Bryan had never doubted. Not when thirty-eight years before, an American singer had offered to pay a cool one million dollars for a single trip to the old Russian space station.

After that, TPO gave him his head, and he hadn't let them down. The Gemstone Cup had been his idea. So had the OmniNet concerts. And now, although he didn't look forward to Jessica Longworth's arrival with unalloyed pleasure, he knew why she was coming. If he was successful with her, he would accomplish his biggest coup since coming to Moonbase.

The Merry-Go-Round Ball.

He licked his lips. If they thought he'd worked miracles before, they hadn't seen anything. If he could bring the Ball to Luna, the ramifications might extend far beyond his simple hotelier's purview. Which, he reminded himself, he must discuss with Hank Evert. He might need to haul in the heavy guns.

"Good morning, Bryan."

He started slightly. "Oh. Jack, Nancy. Good morning to you."

His Executive and Food & Beverage Directors smiled back at him. "Hungry?" Nancy Etcheberry, the Exec said. "Jack recommends the sweetbreads. Says they're something special."

Jack Olson grinned. "They should be. Bryan pummeled the Chef into fixing them himself. You want to tell us what the occasion is, boss?"

He gathered them in and shepherded them toward their usual lunch table. It would be, as always, a working lunch. "Yeah, guys," he said. "The occasion is Jessica Longworth. And the Merry-Go-Round Ball."

He enjoyed the way they both turned silent and thoughtful. They had both known she was coming. Now they knew the reason, and the stakes, as well.

The first thing you thought of when you met Thorvald Heimdahl was "heavy." There was a slow ponderousness to his body, thick and slablike, and to his movements, which seemed as inevitable as avalanches. Thor Heimdahl obviously knew his own mind, and trusted it. His eyes possessed bite—they chewed at the listener (around Thor, most people listened), and their gnawing, digging quality was enhanced by their size and color: extremely dark brown, the color of flint chipped into knife blades. His eyes weren't particularly large, and they were evenly spaced beneath narrow brows that shaded, rather than revealed, their expression. His

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nose was a vegetable, a potato, perhaps, but peeled white and shiny. In an era of contact lenses and ocular surgery, he affected narrow, rectangular, steel-rimmed eyeglasses, so that his gaze seemed caged behind thick windows. Those who received the full impact of his attention, however, were grateful for the shield. Thor Heimdahl's eyes stripped you naked and feasted on your bones.

His head was utterly bald. His hands were those of a workman, thick and matted with black, curly hair. His heavy muscles were concealed beneath a layer of hardened fat.

He lay on his bed in the Presidential Suite of the Imperial Loony and said to Denis Chickering, "Are you sure you understand?"

Chickering, a smooth, blond type whose nondescript blue eyes never met a face square on, said, "I believe so, sir. The bartender, that Niven kid. Check him out, see if there's a way to get to his father through him."

Heimdahl nodded. "Don't screw it up, Chickering. Don't alert the, ah, quarry. If you are successful, your career will benefit. If not—" Heimdahl spread his big hands and shrugged.

Chickering stifled a shudder. "I'll be careful, sir. You know I will."

Heimdahl smiled, and Chickering thought of hunting animals—wolverines, or sharks. "Good. See to it."

It was a dismissal. Chickering turned and left the room. Heimdahl opened another button on his shirt. His comm unit was blinking silently, its screen a mosaic of red alarm lights. His empire called, but it could wait. He had two goals for this trip. The first, to win the Gemstone Cup. The second, to obtain the secrets of the hyperforce generator. Business and pleasure. Business and revenge.

What a satisfying mixture.

Arnold Rothstein said, "You get your ass out of here and you get it done. You understand me, rat bait?"

The hapless roadie—Arnold thought his name was Fred, but wasn't sure, he never kept track of the people around him—stuttered some kind of reply, sprayed saliva in a general cloud, and backed nervously out of the suite.

"And don't slam the — " *Slam!*— "frigging door . . ."

Arnold shook his head. Where did these people come from? It was this damned Moon gig. He understood how necessary it was to his career, but what a frigging mess! Normally he traveled with an entourage—he liked that word, entourage—of three hundred people, roadies, hangers-on, gofers, and a phalanx of assorted management types. But the Loonies—he knew they didn't much like that name, but he didn't much give a jolly frig, either—had told him the limit was six. Only six people to pamper, care for, protect, and *love* the incredibly wonderful persona that all the world knew as Slash.

From little Arnold Rothstein to Slash. What a frigging trip. Was it not, boys and girls? Tell you a story, see: once upon a time there was a nerdy kid named Arnold. You know him, everybody knows somebody like him. Wears thick Coke-bottle glasses because he's too poor to afford contacts, never has the right hair, always sports real geek clothes, cause his dear mama buys them for him. Oh, yeah, you remember now, the kid

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that always got beat up by the biker types, always suffered from advanced pizza face, and never had a real date all through high school.

You remember, don't you? Well, so does Arnold Rothstein, Arnold thought. Good old nerdy Arnold remembers everything, and now, through some electronic musical wizardry little Arnold has been transformed, yes, frigging *transmogrified*, into arguably the most famous person in the entire world. Friends and neighbors, he just wants you all to know he's still keeping score. Arnold is still taking names, boys and girls, and you can bet your ass there'll be a test later.

Not a test, he decided. A *triumph*. He'd taken a year off, after his record-breaking Whiplash tour, but now he was coming back. Let those idiots who said the Red Rooster was bigger than him kick back and watch. That old skinny bird didn't stand a chance, not after this concert. What he had planned—old rockin' robin was about to become stewed goose. What he had in mind was gonna *murder* that sucker.

Such thoughts occupied his time while Arnold Rothstein, aka Slash, the Slasher, the Ripper, legend in his own time, made ready for the biggest concert of his life.

It would be a heller, he promised himself, oh yes, a total frigging brain bomb, the greatest concert the world had ever seen. When Arnold Rothstein got through with them, *that name* would be buried forever. All of it would happen, if he could just figure a way around this albatross, this cannon ball hung round his neck. This barf bag what-did-he-call-himself General Manager, this obstacle, this Edwards.

He glanced at Omega, who sat silent and dead-faced on a chair in the far corner of the suite. He never let Omega out of his sight. It had taken a lot of very special effort to find Omega, but it would be worth all the trouble. A secret smile animated the cold, rat-like features of the old Slasher as he considered ways and means. That was one thing he was real good at, Slash was—nobody better at getting his own way, through his own means.

It would be an interesting day, he decided, and threw a full bottle of Absolut Vodka, eight hundred bucks on today's black market, through the big mirror on the ceiling above his bed.

Let the friggers clean *that* up.

It was, after all, only money.

Jessica Longworth stirred uneasily as her transfer shuttle settled down on a tail of fire to finally perch on three stilt-like legs a few feet above the utterly silent Lunar surface. The pink-cheeked face of the pilot appeared on the screen before her eyes.

'How are you, ma'am?''

He seemed so *young*. But then, so did everybody else, these days. She smiled at him and said, ''Just fine, Captain,'' ignoring the fact that he'd already protested he was only a lieutenant. To her, veteran of uncounted flights on the old Concorde and her own private plane, the man in charge was captain. Finis—she was too old now to change her ways.

''Good,'' the young man replied. ''We'll be unloading in a few minutes.''

''That's fine,'' she said vaguely, and turned away from the screen. The in-

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terior of her small cubicle stank. Well, perhaps that was too strong a word, but in her everyday life, her patrician nostrils were seldom assaulted by the medley of odors normal to space flight. No machine oil, or dead, filtered air, or sweat, was permitted to sully the confines of her five houses or eight apartments scattered in every desirable part of the globe.

But oh, her bones did ache. They ached all the time, of course, but gave her even more pain than usual today. Was it simply the unaccustomed rigors of the flight? Or was it tension, as her body responded to the turmoil of her mind?

This would be the most important journey of her life. She had come to bargain, as she, a woman, had bargained all her life. Something for something. It was the way of the world, and she understood it quite well. The fact that she was bargaining *for* her life—well, she had done *that* before, too.

She sighed and patted the head of Shou-Shou, the most elderly of her trio of Pekes. The dog made a small whining sound and tried to lick her fingers, but was restrained by its tiny harness.

"There, there, old girl," she said softly.

Still, she—a woman old enough to have become bored with even her own glittering life—felt a stirring of interest. The old game to play, the one she'd always known how to play better than anyone else.

She sensed that Bryan Edwards, and behind him the mysterious human infrastructure of Moonbase itself, would be a worthy opponent. But she had brought what she judged great gifts, and would not trade them away for less than her own goals.

If she failed, then everybody would be the poorer.

But she didn't intend to fail.

The door opened and people came in and she willed some iron into her spine. She shrugged away the helping hands.

"Leave me be," she said. "I can do it myself."

She always had, hadn't she?

"Jessica, my dear, welcome."

She stood in the entry foyer of the Diamond Room, her maid behind her controlling the Gucci leashes which constrained her three decrepit, yapping dogs. They regarded each other. He had known her for a long time, but at every new encounter he was always taken afresh by her striking presence.

Jessica Northwood was very close to seventy years old and, in some ways, she looked it. She has scorned the cosmetic surgeon's arts as beneath her, but she appeared younger than her seven decades in the ramrod way she held her spine, in the set of her wide shoulders — she'd once had a fling as a model in what she called her flaming youth — and in the aggressive sharpness of her deep-set agate eyes. There were wrinkles in her neck, and lines fanning out like spectral maps from her eyes, the bridge of her slightly beaked nose, and from the corners of her wide, full lips. Yet her voice was clear and strong and willful, and her movements absolutely sure.

She wore Givenchy impeccably, as always. Gray was a good color for her. It both complemented and set off her mane of white hair. She had never been

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beautiful, but she had forever been stunning. And still was.

"Thank you, Bryan," she replied. She reached out to take his hands. "Perhaps you thought I might not visit again."

He smiled softly, captivated by her spells. "I never doubted, Jessica."

She raked him with a mocking glance. "Really? At our age, darling, it's best to doubt. I, personally, avoid eggs cooked longer than three minutes. That way, I can presume I'll be around to eat them."

He chuckled, bowed slightly, and led her into the room. After she was settled, she patted the seat of the chair next to her. "Sit with me a moment, Bryan. We have things to talk about."

He kept his face immobile, but inside, his stomach did two abrupt deep knee bends. He hadn't expected her to come to business so quickly, and felt unprepared. The faint smile she bestowed upon him as he seated himself confirmed that she was well aware of his predicament. No doubt, he sighed inwardly, she had planned it that way.

But he allowed none of this to show. "René has fixed sweetbreads," he said.

"Of course. Poor René. You don't tell him, do you?"

"About the Pekes? No, that remains our little secret."

"Good. He does other things so well, it would be a shame to disillusion him about his extremely expensive dog food."

He stared at her, trying to conceal the affection he felt for this last of the true grande dames. She was a great lady, but she would exploit that fondness ruthlessly. As, he reflected, she no doubt already expected to do.

"You made this place," he said. His voice was musing.

Her lips tightened slightly. "Normally, Bryan, I would gracefully protest, and give you all the credit. But I don't have time for that now. Truthfully, I did. I still remember the day you called."

And again they exchanged glances. He'd made big promises to the TPO, and then run into snags. His initial plan had been to invite the elite of the show biz world, but they hadn't come. Nor had the politicians. Finally, he'd been turned down by a laundry list of minor royalty, even garnering refusals from nothing better than Eurotrash. In desperation, he'd turned to Jessica Longworth. And she had pulled his chestnuts from the fire.

"Of course, Bryan darling, I'll come. I've missed you, and besides, I've always wanted to visit the Moon. Even as a little girl."

And come she had, with full OmniNet coverage, accompanied by a retinue of thirty, an obnoxious Irish gentleman whose job it was to chronicle the mad doings of the rich and famous, and, of course, her three dogs. Everybody had been younger then.

Within a month the tide had turned. She had cheerfully forked over the fifty thousand asking price for the Imperial Suite. Approximately one hour after the Irishman had revealed that fact to a breathless world, two of the younger members of the Kuwaiti royal family had booked reservations, followed quickly by the young Duke of Edinburgh, members of the three greatest Boston clans, and an errant scion of the Japanese Imperial house.

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Jessica Northwood Longworth's name meant something in a very elite world. It still did. One of the things it meant was the Merry-Go-Round Ball.

Eric Linsdorff, the maitre d', glided over with a nicely chilled bottle of Dom Perignon. The Diamond Room kept exhaustive files on the preferences of all its guests, and many more who might someday become customers. If you were above a certain level, you would always be well cared for here, even on your first visit. Jessica had always had a fondness for that particular bubbly. She gestured for Eric to pour without a tasting. It was unthinkable that the Diamond would serve bad wine.

"I remember, too," he said. "I owe you a debt for it, Jessica. Have you come to collect?"

"Oh, don't sound so gloomy, Bryan. You owe me something, true, but I haven't come without a tat for your tit."

"The Ball?" he said.

"The Merry-Go-Round Ball. Yes."

"What do you want, Jessica?"

She shrugged. "There merest nothing, dear boy. I want to stay. That's all."

He regarded her thoughtfully. "Here? On the Moon? You mean emigrate?"

She nodded.

He sighed. "Your tat, I'm afraid, puts my tit in a very big wringer."

She patted his hand. "Don't worry. We'll work it out."

Once the major cards were on the table, Bryan found himself able to relax. The problem she presented went to the roots of Moonbase, and the solution might lie far above him. He would have to see. In the meantime, it was nice to sit back, talk of old times, and enjoy her presence. She sipped her champagne and fed near priceless bits of meat to her dogs. Her maid sat stony-faced across the table, doing a wonderful imitation of a stake connected to three leashes. They both ignored her entirely.

"I see you have that dreadful Heimdahl man in residence," she said.

"Mm hmm. He's in for the Cup."

She brightened. "My grandson will be competing, you know."

"Really? What team?"

"British Royal."

"Ah. Nice."

She nodded with satisfaction. "I still have—what is the vulgar word?—clout."

They both grinned. "Of course you do," he said.

"And who is that extremely ugly young man, the one with all those unsavory attendants gathered about? He seems to be glaring at you."

"That is Slash," Bryan said. "He doesn't like me." His voice was carefully without inflection. Whatever he might personally think of any guest, that opinion would never be expressed, if it were uncomplimentary, in public.

"That's Slash?" Jessica said. "He's very popular, I suppose. I saw him on the Net once. I didn't think it possible he could be uglier in person."

Bryan stifled a grin. "He heaved a bottle of vodka through the mirror in his suite this morning."

"Oh, poor Bryan."

"Poor Slash, you mean. You wouldn't believe what I charged him for it."

"Ah, the soul of an innkeeper."

They chatted. Eventually the Dom was gone, and Gary Niven was sum-

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moned. Jessica wouldn't allow anyone else to make her Sazeracs.

"The boy's a genius," she told Bryan.

He nodded. He was coming to wonder if Niven might not be a genius in other things, as well. But that would take further investigation. In the meantime, he intended to enjoy his afternoon.

Night would come soon enough.

After his pleasant but unsettling lunch with Jessica, Bryan returned to his office to double check the final arrangements for this year's Gemstone Cup. After a time he put aside the printouts, tilted his chair back, and gazed blankly out his window.

The Cup had been one of his ideas. There had been an annual crawler race from Moonbase to the Fra Mauro region across Mare Nubium for many years before he'd come to Luna, but it had been a makeshift, unofficial competition. Bryan had said to Hank Evert one day, "Listen, Hank. The America's Cup is one of the biggest sporting events on Terra. As is the Monaco Grand Prix. But this little crawler race of yours, it could become the biggest of them all, with a bit of help."

Evert had eyed him skeptically. "What kind of help, Bryan?"

Bryan had shrugged. "Oh, a nice trophy, for one thing. And a reasonable entry fee."

Evert still remembered his opposition to the overnight charge for the Imperial Suite, and thought he knew what was coming. "How much of a reasonable fee?"

"Mm, say ten million?"

"Ah. And what is your idea of a nice trophy?"

"There are meteorite gemstones on the Moon, aren't there? And if we can't find suitable ones, don't your tech people manufacture diamonds and emeralds and such?"

Cautiously, "Well, yes. So you want a trophy with a diamond or two on it?"

Bryan had nodded. "Yes . . . I think about three thousand carats ought to do it."

He grinned faintly. As always, Evert had been shocked, but even so, he'd done the job. The Gemstone Cup stood four and a half feet tall, simple stainless steel salvaged from historic space wreckage, and studded with jewels so thickly the metal was almost completely hidden. The centerpiece of the cup was a single ruby which divided the stem, a perfect pigeon blood of eight hundred carats.

This year there would be twenty off-world teams adding their custom built crawlers to the thirty or forty Lunar teams. There were two divisions—local and off-world. The Gemstone Cup was awarded to the foreigners, who hadn't blinked an eye at the entry fee. On top of it, all teams paid Moonbase, Inc., a great deal of money to construct their tailor-made vehicles. Added together, the fees, plus the building costs, plus the fans who came to cheer their favorites on, added nearly three hundred million hard dollars to the Lunar economy.

Of course, there were headaches. Thorvald Heimdahl, after six years of trying, had never finished better than second, and that only last year. Bryan knew something of Heimdahl, and won-

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dered how long it would be before the man resorted to tactics he was already famous for downwell. Some rumors had come to him that it might be this year. He hoped they weren't true, but he would guard against them anyway. Sabotage, on the unforgiving Lunar surface, was no joking matter.

And then, of course, the grand finale of the Cup weekend, the Slash concert. At first, the TPO had wanted to subsidize transportation from Earth to the Moon for willing performers. Bryan had laughed.

"Are you kidding, Hank? You hook these people into OmniNet, record the hell out of everything, they stand to make maybe a hundred million bucks. Why in God's name should we pay *them?*"

Evert, now inured to Bryan's schemes, simply spread his hands and said, "How much?"

"Twenty percent of the gross."

The Slash concert would net Moonbase about thirty million, it looked like. Unless something truly weird happened with Slash himself. The man was pathologically unable to accept any kind of authority. Bryan worried that Arnold was planning something theatrical, illegal, and perhaps even psychopathic.

It would all come together tomorrow. And now Jessica's little problem, as well.

Yet that was what they paid him for, wasn't it? He put his hands behind his head and closed his eyes. His computer chimed. The sound was low and mellow in the silent office.

"Yes?"

"I have those reports on the Tranquillity Bar," the sweet, expressionless voice of his machine said.

"Good. Hard copy, please."

As he waited for the printer to finish spewing printouts onto his desktop, he nodded with satisfaction. The day to day work of the hotel went on, even in the midst of what looked like glamour to the uninitiated eye. He prided himself on keeping costs in line with the budget. So what was young Gary Niven doing in the Tranquillity Bar to screw up those numbers so badly?

At five o'clock he put his work aside and shut down the computer. The figures were clear enough, but Bryan wished to see for himself. He knew what Gary was doing, but not how, and how was as important as what.

As he stepped out of his office he realized that his back ached. He paused, stretched, and kneaded the muscles at the base of his spine. Tension, no doubt, brought on by stress. Or age, he thought grimly. And he hadn't gotten in his exercise quota for the day yet. He resolved to take care of this bit of business and then spend an hour in the hotel Health Club. It would do him good.

Five minutes later he entered the Tranquillity Lounge, named after the famous Base where Buzz Aldrin and Neil Armstrong had landed their Apollo 11 craft and become the first humans to walk upon the Lunar surface. The lounge was humming, packed with Cup team members, big time gamblers, assorted celebrities from the media, and the basic mega-rich who always peopled events of this sort. Slash was huddled in one dimly lit corner with three of his people, including the disconcerting Om-

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ega, who gave Bryan chilly lumps in his gut every time he saw the flat, dead features of the roadie.

Thor Heimdahl was paying court to Jessica Northwood. It was strange, Bryan mused. Heimdahl was far richer than Jessica, yet Jessica treated him like a peasant. The reason was obvious and, in a way, the same reason that Bryan's efforts with Moonbase had been so successful. Jessica's lineage went back centuries. Her family had been a social fixture while Heimdahl's ancestors were peddling stolen cattle in Norwegian back-country kraals. Above a certain level, money ceased to have meaning to the players of the game. Only status, as conferred by those who held status, mattered. Thus the Heimdahls of the world followed the Northwoods, and not the other way round. Just as the status conferred by being able to drop into conversation, "Last week in the Tranquillity, where I was talking to . . ." or "Of course I'll be at the Cup, won't you?", was something worth far more than the simple cash involved. When you guested at the Imperial Loony, you were *somebody*, on a scale far above the merely wealthy.

So crass, Bryan thought, and then he grinned. Of course it was crass. Much of life was crass. And he was lucky to find himself in a position to take advantage of it.

He wandered casually over to the bar and leaned against the polished steel counter rail. Gary, coming into the final hours of his shift, was busy at the far end, deep in conversation with a shifty-eyed blonde man whom Bryan didn't immediately recognize. But when the man passed something to Gary, who quickly slipped it into his jacket pocket, Bryan's eyebrows rose. This wasn't what he'd expected to see.

The blonde man left the bar, went to Heimdahl, bent over and whispered something into his ear. Heimdahl nodded and waved him away.

Stranger and stranger.

"Yes, Mr. E.?" Gary said. He stood directly in front of him, smiling across the bar.

"My usual, Gary, please."

"One Laphroaig with two ice cubes, coming up," the boy said cheerfully.

It was a shame. Gary's smile and his easy skill were definite assets to a hotel like the Loony, especially since Bryan's hiring pool was somewhat limited. The children of the scientists and engineers who worked in other divisions were about all he could get. He knew it took at least twenty years to make a classic, European-style serving person, and so he had to make up for the lack of quality by increasing the quantity. It all contributed to his heavy labor costs, but in the end, it was worth it—although an occasional find like Gary, whose ability stood out like a cherry on an ice cream cone, certainly made life easier.

The young barman brought his drink and slid a napkin beneath it with a charming flourish.

"Enjoy, Mr. E." He paused. "Good crowd tonight."

Bryan nodded and raised his glass in a slow toast. "To good crowds, Gary."

"You got that right, sir."

Bryan watched him move back down the bar to field a complicated order from a group of high rollers. He narrowed his eyes. No matter how clever, they always

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made a mistake. And he would catch it.

That was *his* job.

It took him almost an hour to figure it out, and when he did, he was surprised at the simplicity of it. No, on second thought, he wasn't. The best schemes were always simple. He watched Gary pull his little routine one more time, then caught his F&B Director's eye. Jack Olson was at the door, conferring with the maitre d', but he saw Bryan's unobtrusive gesture and hurried over.

"What's up, Bryan?"

"Why don't you watch our star barman for a little while. Tell me what you think."

Olson's broad forehead corrugated a bit. He was a youngish man, educated at Cornell University's Hotel and Restaurant school, but he also carried a psych degree from New York University. All he needed, Bryan thought, was a little seasoning to become an excellent hotel man. And this would be a dash of that seasoning.

Olson ordered a Jack Daniels rocks and edged around Bryan until he could survey the back bar area without revealing his scrutiny. He sipped slowly and made small talk, but Bryan was pleased to see Olson's heavy-lidded gaze track every move Gary made. Finally, the younger man drained his drink and said, "It's a ringer chip."

"Good, Jack. Excellent. You spotted it sooner than I did."

Olson was glum. "Damn it, why do they think they can get away with it? And he's a good employee, too."

Bryan shrugged. "Good workers steal. It's no guarantee."

"I know, but—"

Bryan sighed. "Tell me what you saw."

"He's working the drunk in the middle of the bar. What's his name, Bubby, Bucky, something like that?"

Bryan nodded. "Bucky Buckingham. More money than brains."

Jack looked disgusted. "Must be. Does he ever check his bills, I wonder?"

"Bucky? A bank trust pays for everything. Bucky just spends it."

"Well, our boy picked a good one, then." He paused. "He must talk to them, mark his pigeons carefully."

Bryan nodded.

"Well, when Bucky ordered his last round, Gary presented him with a check-chip, all right, but he took it out of his pocket. . . ."

The check-chip was the way the Tranquillity handled its customer billing procedure. Guests of the hotel never used cash. Everything was charged to their room. However, when a drink was served, a check-chip was presented with it. The customer ran his tab on the rectangular card, which contained a chip that kept track of all charges. There was even a tiny keyboard, for the addition of a tip. That was where Gary was getting over.

"Bucky is thumbing for his drinks as he goes. Gary has a dummy chip, where he can set the tip. The guest thumbs out, and Gary reads the total back into the machine, so that all the booze sales are accounted for. That way, the liquor cost isn't thrown out of whack. However, the tip is set to whatever Gary wants it to be."

Bryan nodded again. "That's it. I got

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onto it when I pulled a record of Gary's tips over the last few months. For most of the last year, he's averaged about twenty percent. OK, though not spectacular. But in the last two months, his average jumped to almost thirty-five. He's a good barman, but not that good."

Olson nodded. "He's not stealing from us at all. But he's hitting the guests pretty good. I wonder what he thinks? They're rich, they can afford it?"

"Something like that. Something stupid."

"What are you going to do?"

Bryan exhaled slowly. "Fire him, of course. This is the Imperial Luna. We don't employ thieves."

Olson shook his head. "Bad business, damn it. When are you going to do it?"

"Right after his shift. Bring him up to my office then. And I'll want you on hand, if you don't mind."

"Sure," Olson said. His expression became troubled. He started to say something, then stopped.

"Is there a problem, Jack?"

"I don't know. I don't want to say anything yet. Maybe no, Bryan. Let's wait and see."

Bryan stared at him steadily. "Something I should know?" He had the oddest feeling that now Jack Olson was testing *him*.

"No. Forget it, Bryan. It's nothing."

The feeling grew stronger. But Jack was obviously uncomfortable. "OK," Bryan said at last. "If you say so."

Nancy Etcheberry, his Executive Director, was waiting for him in the anteroom of his office. At this time of day, the area was deserted. She sat on the concierge's desk just outside Bryan's door, swinging one foot nervously, her blue eyes slightly glazed with concentration. Two thin lines had sprouted over her nose.

"Bryan, I've got a problem. Rather, I think we have a problem."

He nodded. "OK. Give me half an hour. Can it wait that long?"

"I think so."

"OK." He moved past her into his office, but as he seated himself at his desk, he had the sudden notion that everything was falling apart. True, only Gary Niven was actually on the current agenda, but Nancy was very experienced, very level-headed. And very determined to prove that she was as capable as anybody. Sometimes it led her to keep things to herself that she shouldn't. If she was worried enough to bring it to him, then there was a real problem brewing. And how many others? Jessica, Gary, and now something else.

His computer announced Jack Olson. The F&B man entered with Gary Niven in tow. The young barman's face was carefully neutral. He flashed a blinding smile in Bryan's direction, but Bryan could see a sharp undercurrent of worry beneath Gary's calm exterior. And the smile never reached his eyes.

"Hi, Mr. E. What's up?"

"Sit down, Gary, please," Bryan said, and pointed to a chair in front of his desk. Olson stepped back a few paces, where he could watch, but wouldn't be in Niven's field of vision.

When Bryan finished, Niven stared at him blankly. "So you're firing me?

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Just like that? I do a good job for you, Mr. E."

"Yes, you do. Except for the stealing. You knew better, Gary. I'm sorry. But it's over now." He began to stand, but the barman's features suddenly contorted.

"Not quite, it isn't, Mr. Edwards. What's my name?"

Bryan paused. He sensed Jack Olson's interest sharpening. "Gary. Gary Niven."

"Uh huh. Anybody else on Moonbase with a name like that?" Gary's words held an undercurrent of sly triumph.

Then Bryan saw it. "Oh. Your father. Frank Niven."

Now the triumph became obvious. "That's right, Mister General Manager. Frank Niven, the head of the Moonbase Hyperforce Project. You may be pretty big in your stupid little hotel, but compared to him, you are chicken crap. You think you're just going to fire me, and that's the end of it? Well, think again. It's not going to be that easy."

And the young man suddenly snapped out of his chair and headed for the door.

"Gary, wait!"

But he was gone. Bryan stared at Olson. "That what you were worried about?"

Olson nodded unhappily. "I didn't know whether he'd pull that horse dooky or not."

"You should have warned me."

"His old man's pretty powerful, Bryan. What are you going to do?"

"Fire his son. What else?"

But that only made Olson look even more downcast.

* * *

"OK, Nancy, what little bit of nastiness have *you* got for me today?"

"Is it that obvious?"

"Well, my afternoon hasn't been exactly pleasant. Why should you be different? Go on, spill it."

Her blonde hair was always perfectly coifed, but now she reached up suddenly and ran her fingers through it. Bryan's eyebrows rose.

"Oh, hell," she said. "I'll let him tell it." She went to the door, opened it, and said something to someone outside. Then she stepped aside to admit a skinny, pockmarked youth with a neon mohawk haircut that flashed and glittered like a bizarre Christmas tree.

"This is Fred Hilborn," Nancy said. "Go on, Fred. Tell Mr. Edwards what you told me."

Bryan stared at this newest apparition. He was one of Slash's group, an all-purpose gofer. Fred licked his lips. His eyes darted wildly, refusing to focus on Bryan.

"Yes, Mr. Hilborn? You have something to say to me?"

Finally, the roadie nodded. "Slash," he mumbled.

"Speak up, please. I can't understand you."

The words came out in a rush. "It's Slash, he's gone crazy, you know that dummy he's got, that dummy Omega, I don't know where he found him, but oh, Jeez, what a mess."

Bryan shook his head. "What? I don't understand."

Fred took a deep breath. "The dummy, Omega," he continued more slowly. "He's a psycho. Some kind of depressive. He wants to die."

The two men stared at each other.

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Finally, Bryan said, "Is this a problem for me, Mr. Hilborn?"

Fred's voice was almost a snarl. "You better believe it, buddy. Omega wants to die, and Slash is gonna oblige him. Gonna cut him up. With a sword. Right on stage, in front of God and everybody."

Bryan looked up at Nancy. She stared back, her eyes wide.

"Oh, shit," Bryan finally said. "Oh, holy shit."

The final event of the worst day of Bryan Edwards's life came after he'd gone to bed and almost, after an hour of tossing and turning, achieved sleep. Hit hotwatch alarm sounded, jerking him wide awake.

"Yes?" he said into the darkness.

His computer unrolled the comm screen on the far wall. It lit up, casting an unearthly greenish glow on Bryan's taut features. A man's head appeared on the screen. "Mr. Edwards?"

Bryan recognized him. He was Tan Mong Seng, one of the technicians attached to the crawler construction teams. "Yes, Mong Seng? What is it?"

Tan's flat eyes flickered slightly. "You know I've been working on the Brit team's buggy?"

"Yes."

"Well, about an hour ago, somebody offered me two million bucks to fix it up with a thermite bomb."

"Oh, Jesus," Bryan breathed softly. "Do you know who it was?"

"Bet your butt, Mr. Edwards." Tan's voice was flat and positive. "It was that Heimdahl guy. Thorvald Heimdahl. I just thought you ought to know."

Bryan nodded. "Thank you, Mong Seng."

The screen rolled itself back up, and the room went dark. But Bryan Edwards didn't sleep, not until an hour before "dawn," and even then, not very well.

The hotel maintained an artificial dimming of its public lighting which corresponded to "dawn" and "dusk," for the convenience of its guests. Bryan rose shortly after dawn and headed for the Health Club. His employment contract specified an hour of exercise a day, and he had missed his quota for the day before. He decided on an hour of jogging, followed by half an hour's work with the weights. Besides, he hoped the workout would clear the cobwebs from his brain. Yesterday had been a bad day, and today looked to be even worse.

He wasn't disappointed, for when he stepped out of the Club's ultrasonic scrubber, his personal comm unit was blinking its red message light. He finished dressing and patched into his office computer.

Hank Evert, sounding nervous and touchy, had left a message: "Bryan, I need to see you in my office. Nine o'clock, please."

He could guess what *that* was about. He left the Club, moving quickly for the Outlook Room, which would be serving breakfast by now. He had just enough time for coffee and a quick bite before the confrontation. For confrontation it would be; he was very much afraid that Hank was preparing to overrule his decision to fire young Niven. And if that was the case, then he had another choice to make: whether to tender his own res-

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ignation. Right at that moment, he wasn't sure what he would do, but all his instincts told him to stand his ground. If the exigencies of Lunar politics dictated that he keep a thief on his staff, then perhaps the Imperial Loony was not the place for him to finish out his career.

Mary Gibbs, the fresh-faced sixteen-year-old daughter of an engineer attached to the second Mass Driver project, served him his toast, coffee, and home-grown chicken omelet. She displayed her usual cheerful smile, but he caught her glancing oddly at him as she left the floor after punching in his order on her touchpad. Word had already got around, he decided. Sometimes he wished his official comm system functioned as efficiently as the hotel grapevine.

At ten minutes to nine he walked over to the Moonbase Corporate Headquarters building. As always, he was struck by the incredible beauty and strangeness of the Main Plaza. The huge space, the equivalent of seven football fields in length and twenty-five stories high, was floored with an undulating plain of greenery, part of Moonbase's air regeneration and food production system. Farms on the Moon. He never ceased to marvel. He skirted the brightly-lit, zigzag canyon (115 feet deep), of Undertown, where most of Moonbase's personnel lived and worked. The deep thrum of rail-guided plasma torches reached his ears. The huge machines were gouging out yet another level, the sixth, to accommodate the Base's growing expansion. He took off his suit jacket and slung it over his shoulder. The dry, moderate atmosphere beneath the dome reminded him of Phoenix in the springtime.

Ahead loomed the HQ building, a fantasy of chrome and glass boxes strung like oddly shaped beads from a center shaft fifteen stories tall. It had been designed by the architectural firm I.M. Pei, who had donated their work for the honor of building the first office structure off the Mother World. It had been a good deal for them. They featured Moonbase HQ in all their publicity handouts. To the Earth-trained eye, the structure looked impossible, far too flimsy to stand. But in the one-sixth gravity of Luna, the building was solid as any Terran skyscraper—moreover, there were no winds for it to contend with.

He took an elevator to the seventh floor, which housed the offices of the Tourist Program staff. Hank Evert met him in the anteroom to his own office, a worried look on his face.

"Something wrong, Hank?" Bryan asked mildly.

Hank shook his head. He had a plastic cup of coffee in his hand. His receding hairline faded into crew-cut white hair, which made his brown eyes appear large and sad. Bryan thought he was a good guy, but maybe a touch too conservative.

"You know damn well something is," Hank said. "I don't know why you—" He cut himself off abruptly.

"Young Niven? It seemed cut and dried to me. The boy's a thief."

Evert frowned. "His father is very upset, Bryan."

"He should be. I wouldn't want my son stealing, either."

"It's not that!" Evert exploded. "He's

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already talked to me. Says the boy is sorry, promises to never do it again. Just a childish prank, he calls it."

"Hank, it took planning and skill to pull off his little scheme. And it's been going on for months. The only reason for this sudden conversion is he got caught."

Evert shook his head again, took Bryan's elbow, and led him into the office. "Don't need to talk outside," he muttered.

When they were settled, Evert continued. "Bryan, I'll lay it on the line. Frank Niven wasn't the only one to call me. Henry Barnhard has also gotten involved."

Bryan kept his face blank, but he knew what that meant. Barnhard headed up the Department of Technical Services. As such, he was one of the two or three most powerful men in Moonbase.

"What does Henry have to say?"

Evert refused to meet Bryan's eyes. Instead, he looked down at his desk top as he mumbled, "You are to give the Niven boy another chance."

"And if I don't?"

Now Evert looked up. "Bryan, don't force me on this." A flash of extreme discomfort blinked across his face. "It's an order from on top, if you want to look at it that way."

"I see. Well, then I guess I have two options."

Evert didn't say anything.

"Do it, or submit my resignation. Does that about cover it?"

"Bryan—"

Edwards stood. "I'll give you my decision by tomorrow. Is that OK?"

"It will be fine," Evert said. His voice was glum. "Bryan, you mean a lot to us. You've done fine, fine work."

"Not fine enough, evidently," Bryan said as he walked toward the door. He wasn't entirely able to hide the bitterness of the words. But what the hell—he *was* bitter.

It wasn't, he reflected, as he returned to his office, that he didn't understand Hank's position. The Niven boy had displayed an excellent understanding of the general scheme of things. His father headed up the single most important research project on Luna, the Hypercharge Group, who were working on the baffling Fifth Force, which might be the secret of anti-gravity. Without understanding the details, Bryan, along with most other residents, believed that a successful conclusion to that project would establish Moonbase as the premiere factor in space technology. Compared to that, the career of a hotel executive, no matter how competent, was small potatoes.

Which had nothing at all to do with his decision. It was a matter of principle. How could he function if he compromised his own ethics? And there was no room in his personal system for condoning theft. If young Niven were allowed to get away with it, what kind of message did it send to the rest of his employees? The charming but slippery barman wasn't his only employee with high-powered connections. No, the more he looked at it, the clearer his options became. He didn't have any options. He wondered how he would adjust to a new life downwell at his age. And suddenly he stopped, just outside the hotel, and stared up at the mighty Glasteel panels

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which framed Earth in all her splendor. He loved the Moon! It would be the breaking of him to leave.

But what choice did he have?

He swiped at his eyes, surprised. Must be very dry today, to make his eyes water like that.

But his face was calm as he entered the hotel. His time might be coming to an end, but he would do this job. Right to the last minute.

Oh, *damn*, what a screw up.

He returned to his desk and busied himself with the never-ending routine of operating a great hotel. First, he read the overnight reports from security and housekeeping. Unlike Earthside operations, his housekeeping department was quite small. Tiny robots did most of the cleaning and upkeep. Matilda Kromwell supervised the night shift and fielded any guest requests. The night, unlike his previous day, had been quiet. Not even any destructive noises from the Slash suites.

Slash. God, what was he going to do about that? If he canceled the concert, Moonbase might well be liable for enormous failure-to-perform penalties. But if he let it go on, and the rock star committed butchery on stage, what ungodly situation would that create? He knew he could talk to Slash, warn him, but he suspected that would only worsen the situation. Slash would probably deny everything, and even if Bryan stationed guards on the stage to prevent the massacre, Slash might walk off. Again charging failure to perform.

Crap. There must be an easier way to make a living.

He quickly skimmed through the daily cost reports, noted that he had three routine meetings, and canceled all of them. Today wasn't likely to be routine. For instance, at eleven o'clock, the Cup race took off from the starting line. The race would last five hours, give or take, and the teams would all return for a victory dinner at six in the Diamond Room. Chef René was laying on his best for that, but he would still have to monitor the food production end.

Which brought him directly to the Heimdahl problem. The Brits had taken the Cup the previous year, edging out Heimdahl's team. Evidently, the devious Swede saw them as his competition again this year, and intended to see their crawler disabled, or worse. Worse, probably; a thermite bomb didn't sound minor. And simply because he'd uncovered one potential bribee didn't mean there weren't others. Heimdahl didn't strike him as a man who would take no for an answer.

God. He leaned back in his chair. His eyes itched. He kept coming back to the Niven problem. What did all the rest matter, if he were going to go soon, anyway? Perhaps he should just let events take their course. If Moonbase could discard him so casually, maybe they deserved to find out what his absence could mean.

But no. No way. Even if Moonbase betrayed him, he still had his own conscience to deal with. He sighed, recalling the sleek, slick movements of the barman as he'd pulled the phony checkchip from his pocket. He could see it in his mind's eye, yes—and wasn't there something else?

He tried to remember. Then he sat forward suddenly, his eyes wide. He

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instructed his computer, which threw up the video records he'd requested. It was an open secret that hidden cameras recorded all doings in the hotel. There was a trade-off between privacy and safety, but on Luna, questions of safety were paramount. He'd had tapes edited of Niven, as necessary proof of his charges. Now he viewed them again, and this time saw it.

There.

"Zoom on quadrant six," he told the computer, and watched as the head of a blonde, shifty-eyed customer filled the screen. He watched the mysterious transaction between the man and Niven, and finally magnified the object that had been passed.

Niven. Guest. Heimdahl. What connection could the three of them have?

A moment later, he called Base Security.

Perhaps he finally had his wedge.

Lonnie Zimmer, head of Security, didn't look like a cop. He sported a thick head of curly brown hair, and eyes of a watery green shade that made him seem vague and diffident. Moreover, his unlined face gave him the look of a slightly lost teenager. Bryan wasn't fooled. Lonnie had one of the sharpest minds he'd ever encountered.

The security man glanced at the screen and grinned. "Ah. Denis Chickering. An old friend."

"What does that mean?"

Lonnie's grin grew wider. "Chickering is Heimdahl's chief of information. Read that as head spy. We watch him carefully, whenever he visits. One slippery honcho, he is. And it looks to me he's at it again." Lonnie turned to Bryan. His face at that moment didn't look young at all. Hard lines glimmered at his cheekbones, and Bryan was glad he had nothing on his conscience that merited Zimmer's attention.

"I think we will search Mr. Chickering's room. See if he's got any more of those widgets."

"What widgets?"

"Like the one he handed young Niven. And isn't that an interesting situation?"

As their meeting ended, Bryan said, "So you see how it ties in with my problems, Lonnie? Can you help me out?"

Lonnie Zimmer smiled slowly. "Bet your buns, Bryan. In fact, I'll enjoy it!"

At ten thirty, half an hour before the race was to begin, Bryan tapped Thor Heimdahl on the shoulder. The big man turned, an unhappy expression on his face.

"Yes, what is it? I'm very busy now."

Lonnie Zimmer stepped forward. "I think, Heimdahl, you'd better make time."

A few moments later they were in Bryan's office.

"I don't care who you are," Heimdahl ranted at the unmoved Zimmer, "if I don't start that race in twenty minutes, you Moonbase people will see trouble like you've never seen before!"

"Just watch this, Mr. Heimdahl," Bryan said, and turned on the screen.

In the gloom, he watched Heimdahl's mouth drop open. Denis Chickering was seated across a small table from Lonnie Zimmer. Between them were several tiny, intricate mechanisms.

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Lonnie said, "You know this stuff is highly illegal, don't you, Chickering?"

The other man's Adam's apple worked slowly, as if he were swallowing something acridly distasteful. He seemed to consider his options, perhaps wondering how far he could bluff. But Zimmer had him cold, and he knew it. He'd seen the Diamond video tapes. There was no way to bluff *them*. At last he nodded, as if he'd made up his mind. "I just follow orders," he said sullenly.

"Oh? Whose orders are those?"

And Chickering told him.

Then the screen switched to another, more familiar scene. Heimdahl watched, a surly expression growing on his face, as Chickering handed the tiny, illicit electronic bug across the bar to Frank Niven's son.

Into the silence as the lights came up, Zimmer said, "Espionage, Heimdahl. I'm sorry, but you won't be competing today. I'm sure you understand."

"I want my lawyer," the big man said.

"And you shall have him," Zimmer said cheerfully. "We already called."

As Heimdahl began to rise from his chair, his face a pale, chalky color, Bryan said, "One other thing, Mr. Heimdahl."

"What's that?" Heimdahl said. His voice was choked with rage.

"About the race. You're in enough trouble now, don't you think? And if something were to happen to one of the other competitors, say, the British Royal team, do you think that would help your case any?"

Heimdahl stared at him. All the color seemed to drain from his eyes. At last, he said, "Do you have a private phone? I need to make a call."

"I understand," Bryan said softly.

Bryan returned from the start of the race to his office and reviewed the films again. Then he called Jack Olson, and Gary Niven.

The young man had entered the office with a triumphant smirk on his face, but now, as the interview approached its end, he sat pale and silent.

"So what do you think, Gary? Maybe your father will tolerate your stealing, but how will he react to espionage? Especially when it was him you were planning to spy on?"

The boy stared down at his lap. He didn't say anything.

"Get him out of here," Bryan said.

When Lonnie Zimmer had collected the would-be spy, Jack Olson came back into Bryan's office."That was amazing," he said. "How did you get on to it?"

"Experience, Jack," Bryan said. "You see enough stealing, you learn to recognize stuff that isn't stealing. Chickering passed something to Gary, not the other way round. It kept niggling at me, until finally I figured it out."

Olson seemed bouncy, almost floating with relief. "Well, whatever. It sure is great, Bryan. Can I buy you a drink?"

"Of course." Then Bryan's expression went as cold as a Lunar night. "Jack?"

"Yes, boss?"

"Don't ever conceal anything from me that might bear on a problem. Maybe I would have caught it right at the beginning, if I'd remembered who Gary's father was, and made the connection.

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You understand? Not ever again. Not if you want to work for me."

There was a moment of silence. Finally, Olson nodded. "I understand," he said slowly. "I apologize, Bryan. It was a stupid thing to do."

"Good. Apology accepted." Bryan came around the desk and clapped Olson on the back. "But now it's done with. Are you coming?"

"Where?"

"Didn't you just offer me a drink?"

He's learning. Bryan thought. He'll do fine.

Jessica Longworth was holding court in the Diamond Room to an audience of small, yapping dogs, and a bleak-eyed maid. Large video screens had been set up, so hotel guests could follow the progress of the race in comfort. Jessica applauded lightly as Bryan slid into a chair next to her.

"What's up?" he said.

"My grandson's team just took the lead."

"Excellent," he said comfortably. "Here's to the Brits."

She smiled. "You don't have anything to toast with."

"Is that a bottle of Dom Perignon I see, cooling off there by your elbow?"

Her eyes sparkled. Again, he felt an unexplainable shiver in his spine. He'd known her for decades. She was a bit older than he, but their paths had crossed many pleasant times. "It is, indeed," she said, and raised one finger. The maitre d' appeared instantly with a fresh crystal champagne flute, which he set in front of Bryan.

"Ah. I'm so glad you drink the good stuff. It makes panhandling all the nicer."

"Makes your balance sheet all the nicer, you mean," she replied. Then her face went serious. "Bryan? Is there any word?"

He paused. Then he took a breath. "I have a meeting with Hank Evert later on today. But, Jessica, I think you should prepare yourself."

Her lips thinned. "For the worst, you mean?"

He nodded slowly. "It's not me, Jessica. You know I lust after the Ball. If it were up to me, there'd be no question." He looked into her eyes. "Even without the Ball, as far as it goes. But I'll do my best."

"The Ball would mean a lot to this hotel. To Moonbase, even."

He nodded again. The Merry-Go-round Ball was the most famous, most elite charity even on the face of the Earth. With its strictly limited guest list, it was the jewel beyond compare for the richest, most powerful men and women alive. To bring it to the Imperial Luna would mean hundreds of millions of dollars, as well as giving the young corporation influence far beyond the mere festivities. He would tell Hank Evert so, but nevertheless, he remained discouraged about the probable outcome.

For what Jessica wanted in return cut to the heart of Moonbase policy. There were about two thousand permanent inhabitants of the Base, which was not yet fully self-sufficient. There was no such thing as an immigration policy, for Moonbase didn't accept those who wanted to come to the Moon simply because they wished to live there. Given the exigencies of the limited resource

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pool, at least until the asteroid mining program showed a yield, each mouth made a difference. And each set of hands must contribute.

"Moonbase doesn't even accept applications for permanent residency until you've lived and worked here for five years."

She bristled a little, her eyes going flinty. "No exceptions?"

He thought of his own recent plight, and Henry Barnhard's readiness to sacrifice him, in spite of his years of good service, to the greater good of the Base itself.

"I just don't know," he said at last. "I'll do my best. You can believe that."

She regarded him stonily for a moment. Then her face broke into a marvelous smile. She touched his shoulder lightly. "That's all I can ask, isn't it?"

A round of cheers broke out on the other side of the room, as the IBM crawler dueled the Brits for the lead. Bryan sipped his wine. "Is there anything you can tell me that might help?"

She shrugged. "What? Just the same dreary sort of thing I expect they hear all the time."

"Your health?"

She paused, as if reluctant to explain further. "My heart," she said finally. "The doctors give me a year, maybe two. They can't repair or replace. Something to do with my immune system. But here on the Moon . . ." She trailed off, her eyes distant.

"It doesn't matter, Bryan. I didn't come here to plead."

And so she hadn't, he realized, as he watched the proud tilt of her nose. She had come to bargain, as best she knew how, and if she failed, then she would return downwell to die. Proud as ever, he supposed, and was suddenly glad that she hadn't resorted to begging.

Stupid, he thought. She wouldn't.

He sighed, and refilled their flutes. A little after three, as the crawlers—some on huge, insectile legs, others rolling swiftly on banks of fat, round tires — raced down the return leg of the race, he took his leave.

"Good luck," she said, and raised her glass.

"To both of us," he replied.

By six o'clock he had his answer, and it was a final one. Moonbase would not breach its policy, not for anybody, not even for the Merry-Go-Round Ball. And Bryan was sad to find that he understood. Luna was in some ways a harsh world, unforgiving to human error. The policies had good and sound reasons for their existence—and Moonbase had more important priorities than the Imperial Luna Hotel, no matter how profitable it was.

Survival came first. And yes, he wanted it that way, too. He wanted the Base to survive, to prosper and grow as man took his first, fledgling steps into the Solar System. That was the important thing, and all else paled before it.

But how would he tell Jessica?

Face to face, he decided. But not now. Not yet.

He glanced at his watch. Lord. He had just enough time to get to the kitchen, before René started rolling the victory dinner off the line.

No matter what his personal feelings, he still had a hotel to run.

And then, of course, there was Slash.

* * *

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By eight o'clock, the great amphitheater in front of the Shell—the huge, airy construct which was the center of Moonbase's entertainment activities — was buzzing with electric anticipation. A few hardy souls wielding miniature videocams swooped overhead, flying under their own power on graceful batwings made of monolayer plastic which was manufactured in zero gravity at Low Earth Orbit factories.

The "outdoor" lights had been dimmed, giving the illusion of an Earth-like dusk, while Earth itself, splendid in white and blue, loomed overhead like a vast, impossibly gaudy jewel. The lights at the shell blazed brilliantly as camera and recording crews, who would transmit tonight's performance to an Earth-bound audience of billions, made ready for the concert.

Slash said, "Frig you, big man. I'm not going on."

Bryan said coldly, "That's fine. Of course, according to your contract, you will owe Moonbase thirty million in non-performance breach of contract penalties."

Slash, his sunken body covered with chrome chains and strips of black leather, his feral, rat-like features disfigured with make-up that simulated open, oozing wounds, snarled something inarticulate and turned away. Bryan thought he looked about as appetizing as a pile of decaying donkey flop. He stood silent as Slash surrounded himself with the three management flunkies who completed his entourage. Fred, the talkative roadie, hovered on the edge, looking nervous and upset.

Too bad, Bryan thought.

Finally Slash rounded on him. "All right," the rocker said. His face had gone a dull, red color, and his voice sounded as if it were being squeezed from a boiling tea kettle. "I'm going on, big man. But you'll pay. Somehow, you'll pay."

Slash turned and stomped toward the stage, where a rising wall of sound signaled his introduction. He stopped and looked over his shoulder.

"Frig you, Edwards! *Frig you!*"

"Indeed, Mr. Rothstein," Bryan replied softly. "Indeed."

On the fifth, lowest level of Undertown, in an unused storeroom, Jack Olson wiped a sheen of sweat from his forehead. The two burly busboys with him settled their burden to the floor.

It was the weirdest thing he'd ever seen, and it turned his stomach. When they'd cinched the Velcro restraining straps around the corpse-faced youth, he'd begun to smile. As rotten teeth had appeared in a hideous grin, Omega had said one long, slow, *greasy* word.

"Tighter."

Olson shuddered, as his guts leaped and clenched like a landed fish. He hoped he wouldn't be sick.

Now he was a kidnapper. What a job.

Learning, Bryan would have said. He's learning.

The noise level in the Diamond Room was deafening. Three bartenders, two men and a woman, poured drinks as fast as they could. The party was on the house, part of the Imperial Loony's contribution to the general festivities.

"What ever happened to that nice young man?" Jessica said. "None of

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these other people can make a proper Sazerac."

Bryan grinned. "I'm sorry, Jessica. He . . . retired."

"A shame," she said.

He nodded, and refilled her champagne flute. To his eyes, she seemed just a bit squiffed, and he couldn't ever recall seeing her like that. She must know, he realized, and dreaded the conversation yet to come.

A wave of fresh hilarity cut through the general din as the British Royals, winners of their second Gemstone Cup, swept into the room from a victory party in a distant suite. Two members carried the Cup itself, which would never leave the Moon. Ordinarily it was displayed in the lobby of the HQ building, but for tonight, the winners would have their moment of triumphant possession.

A tall, extremely handsome young man detached himself from the group and staggered happily to Jessica's table. He bent down and bestowed a sloppy, wet kiss on her upturned cheek. His eyes glittered, both from booze and an all-encompassing kind of glee.

Ah, youth, Bryan thought sadly.

"Bryan, I'd like you to meet my grandson, Charles Longworth."

"Pleased," the young man said politely, and extended his hand.

Bryan shook, and the boy disappeared back into the maelstrom.

"Looks like a good boy," Bryan said.

"I'm proud of him."

Bryan felt a sudden pang. Was anybody proud of him? Would anybody ever speak his name in those intimate tones?

Into the lull of the young man's departure, Jessica looked across the table and said, "Bryan? It's no, isn't it?"

He couldn't bring himself to say it, so he nodded.

She let her breath out in a long sigh. "Don't feel bad, Bryan. I expected it."

He looked away from her face.

"Come on," she said, her voice suddenly full of counterfeit cheer. "It's a party. Have a drink for my grandson!"

And so he did. Many drinks.

He didn't know what he was going to do until he did it. She stood on his balcony, her diamonds glittering in the diffused sheen of Earthlight, a champagne flute in her hand. Her long, white hair, immaculately coifed, gleamed like a helmet of snow.

He joined her on the balcony. She leaned against the railing and said, "It's a beautiful world, isn't it?"

"Yes, it is."

"I wish—" But she didn't finish, and Bryan considered the long years of his own loneliness, and thought his heart would break.

"There is a way," he said at last.

"What?"

"Jessie, how long have we known each other?"

She chuckled, a tinkling, brittle sound. "Oh, years and years, darling. More than I'd ever admit to."

"You're still a young woman," he said, and wonder was in his voice.

"We all are, Bryan. Everybody is young, inside their heart."

"Why have we never—"

Her smile was knowing. "Because you never asked, Bryan. I'm an old fashioned girl. I have to be asked."

Her words hung on the silver air be-

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tween them. Finally, he said, "I'm asking, then, I guess."

Her tone was slightly strained, but her words were soft, and full of warmth. "Is it a consolation prize, darling? I don't mind, understand. I just like to know."

His head shot up, startled. "Consolation—oh. I don't think you understand. Jessica, will you marry me?"

There was a long, echoing silence. Her eyes were as wide as marble coins. Finally she brushed her fingertips across the back of his hand. "Bryan, is this pity?"

"No," he said simply, and realized to his utter surprise that it was true. "It's love."

The next morning, wrapped in the voluminous folds of his bathrobe, she stood on his balcony and drank a cup of coffee. Eventually he joined her. It was Sunday, the closest thing he had to a day off.

"Will I be happy, Bryan, do you think?"

He shrugged. "You can stay. I'm a permanent resident. I qualify for family."

"That's not what I meant."

"I know. I'll certainly try."

"I'm not sure I love you."

And from the wisdom of his sixty plus years, Bryan Edwards said, "Perhaps you can learn."

From her own well of knowledge, she replied. "Perhaps."

Together, they stared out over the great green bowl of Moonbase, where tiny, fragile humans were slowly, carefully, taking the epochal "step for all mankind."

It is a miraculous time, he thought suddenly, and raised his coffee mug. For why not? Wasn't it, at last, the age of miracles? Suddenly his chest filled with joy so pure it threatened to burst his heart wide open.

"To miracles," he said. "To all the miracles of the world."

They drank, in silent harmony, and went back inside. ■

● Science should leave off making pronouncements the river of knowledge has often turned back on itself.

Sir James Jeans

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the reference library

By Tom Easton

There Are Doors, Gene Wolfe, TOR, $17.95, 313 pp.
From a Changeling Star, Jeffrey A. Carver, Bantam, $3.95, 368 pp.
Molly Dear: The Autobiography of an Android, Stephen Fine, St. Martin's, $17.95, 420 pp.
Deep Quarry, John E. Stith, Ace, $3.50, ? pp.
The Assassin Gambit, William R. Forstchen, Ballantine/Del Rey, $3.95, 307 pp.
The Day the Martians Came, Frederik Pohl, St. Martin's, $15.95, 250 pp.
Synergy: New Science Fiction, Volume 2, George Zebrowski, ed., Harcourt Brace Jovanovich, $8.95, 225 pp.
Haunted New England, Charles G. Waugh, Martin H. Greenberg, and Frank D. McSherry, Jr., eds., Yankee Books, $16.95, 287 pp.
Mind Children: The Future of Robot and Human Intelligence, Hans Moravec, Harvard University Press, $18.95, 186 pp.
Selling Science: How the Press Covers Science and Technology, Dorothy Nelkin, W. H. Freeman, $9.95, xiv + 225 pp.

There is only one way to react to the first few pages of Gene Wolfe's latest effort, **There Are Doors**: Gene, *what* have you been smoking now?

The tale is a surrealistic fantasy that begins as a young man and his temporary live-in love, Lara, say good-bye. She's not really a woman, she says. Where she comes from, ". . . . the men die. Always. She holds his sperm, saves it, and bears his children, one after another for the rest of her life. Perhaps three children. Perhaps three dozen . . . your way is so much better. Now I'll go back. Listen. There are doors—." In the morning, a note warns him of those doors: they will look significant, and he must not go through. If he does . . .

Of course he does. He can't help it. When your girl walks out on you, *every* door looks significant. And for him,

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every door brings him to a new and different world, like flicking channels on the TV. The money, the streets, the vehicles, the styles of dress, all change. Not surprisingly, our hero winds up in a hospital, where he learns that his Lara is apparently some sort of goddess, that sex really does kill, and that he is surrounded by nuts.

He escapes, meets another woman, Fannie, returns home, learns that he too is a nut, recovers, lives for years, and then Lara returns. Now he will learn what is really going on and make an important choice—Lara or Fannie?

What is Wolfe doing? He is exploring the basic question, what is love? For our hero, who is one of us, it involves sex. On Lara's world, it exists without sex: Men and women meet, love, marry, and live together for years before they succumb to the temptations of the flesh and posterity. Then he dies. Wolfe thus distills sex down to exploitation, separate from love. But then he gives us Lara, who comes to our world because she wants men who can "make love" more than once. Love and sex can exist apart, he reminds us. Together, they make a treat for the gods.

Don't miss.

Jeffrey A. Carver tells interesting, exciting stories as up-to-the-minute in their technology as anything you could wish. The trouble is that he doesn't tell enough of them, and it has been too long since I last had the chance to praise his work. I am therefore delighted to tell you that his latest offering, **From a Changeling Star**, is as worthy of praise as ever.

There are two technologies involved. One is nanotechnology, the use of microscopic machines to "grow" starships and repair, even reshape, bodies. It enters at the tale's very beginning, when we learn that hero Willard Ruskin has been infected with the things: Someone tries to kill him, and he heals wondrous quickly, even rebuilding parts of his brain. The unwelcome side-effect is that he has a certain amount of trouble with his memory, he seems to have tendencies to blackouts and shape-changing, and one day he finds himself strangling his girlfriend. With her help, and that of a friend, he acquires a second corps of nano-agents to combat his infection, regains some memory, and learns that he is involved in a project to use a cosmic hyperstring to cause Betelgeuse to go nova and (somehow!) form a highway to the galactic center. Never mind the hypothesis that Betelgeuse might be sentient and that the humans, scaled to the star much as the nano-agents are to Willard, may be about to commit murder even as they twist it to their purposes.

From the cosmically small to the cosmically large, Carver is out to blow your mind, and on that level he is a grand success. But does the story itself work? The force that propels it is simple: Two cultures, the individualist Auricle Alliance and the collectivist Tandesko Triune, are jockeying for control of human destiny. The Breakstar Project belongs to the Alliance. Tandesko agents are working to subvert it. A third group wishes an outcome that favors neither Alliance nor Triune.

Poor Willard! The project was his idea in the first place. The Alliance government took it over and bent it to its own purposes. He repudiated it, though he later returned to the fold as a "consultant." Clearly, his nano-agents are Tandesko devices. Or do they belong to the neutrals? He gains partial control of his mind and body and departs for the project. The assassin, determined to rectify its former failure if Willard turns

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out not to be obeying the program carried by his infection, follows.

And it's showdown time. I will tell you nothing more, except that Carver does an excellent job of tickling your sense of wonder, and in the end he leaves you both satisfied and craving another serving of his considerable talent.

The full title of scenarist Stephen Fine's first novel is **Molly Dear: The Autobiography of an Android, or How I Came to My Senses, Was Repaired, Escaped My Master, and Was Educated in the Ways of the World.**

If that doesn't give you a clue, your education has been sadly neglected. In another age of the world, when titles were long and the upper crust could afford servants to abuse, Daniel Defoe, of *Robinson Crusoe* fame, was responsible for quite a different Molly, *Moll Flanders*. As I recall, Ms. Flanders also began life as a servant, escaped, was jailed, turned prostitute, found true love, lost it, had children, joined the revolution, was transported to the colonies, and found fame.

Fine has thus given us another tale of the android (or robot) as the servant class, slave, and nigger of the future. In the process, he has aped Defoe perhaps too closely. His Molly has adventures of her own, for she becomes a movie star, travels in space, has an Automatic Governor installed to enslave her will and make her follow the programs of others. But these differences are trivial. In Defoe's yesterday, sea travel was what space travel will be in Fine's tomorrow. And grand efforts were made to install in the lower classes Automatic Governors—religion, law, custom—that would effectively forestall any will to seek freedom. For that matter, those efforts continue today and independent self-motivators are as subversive as ever. They will continue so in the future, as will the opposing forces of control, of conformity to duty and expectation, of acquiescence to psychological and physical abuse, and that is Fine's point.

I have no argument with that point. Fine makes it and supports it and follows it through very well indeed. Molly and Moll are sisters under the skin of history, and their situations are as parallel as anyone could wish. But why did Fine feel obliged to ape not only Defoe's story but also his style? A little such imitation would have been quite cute enough, but Fine went whole hog and made *Molly Dear* as long-winded as its title. He made it so long-winded, in fact, that several times he felt it necessary to apologize, saying, in effect, "Hey, I know I'm exhausting your patience with these huge expository lumps and long digressions, but bear with me, please. I can't help it!"

For all its considerable charms, *Molly Dear* is a tiresome, pedantic bore.

Deep Quarry is the latest of John E. Stith's science-fictional mysteries. It's bright and breezy, flip and fast, and if it won't stretch your brain cells noticeably, at least it's just the right length for an hour or two in an airport or, assuming your plane shows up, on the plane.

The story is set on the world of Dallad, tide-locked to its sun so that the scene is constantly, brightly, and scorchingly illuminated. Here live humans and three other humanoid species. Among the humans are Ben Takent, private eye, and Kate Dunlet, head of an archeological dig a little ways out of town. When artifacts from the dig show up on the local antiquities market, Kate engages Ben to investigate. This being

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the sort of story it is, Ben promptly entices her into bed and solves the case.

But . . . Despite the tale's obvious kinship to a library full of predecessors, all equally devoid of cerebration or characterization, it does not end there. Ben, aware that the aliens responsible for the site had a habit of arranging their settlements around an elevated center, notices that the site and its outliers frame a massive butte. "Aha!" he says. "You archeologist types should dig a hole or two in the butte, don't you think?"

Answers stuffy academic, "Geddouda here, you goddamn amateur." And then, of course, said academic sneaks a peek at the butte and finds . . . Should I give you a hint? The cover blurb says only, "More people will have to die." So they will, for that butte has contained for 10,000 years a veritable horde of aliens, awaiting Der Tag in suspended animation, and now Our Heroes have rung the doorbell.

No more hints, folks. Suffice it to say that though Stith gives you two mysteries for the price of one, I found the second one the more interesting and wished he had developed it more fully.

The second in Bill Forstchen's *Gamester Wars* series is **The Assassin Gambit**. You may recall that in *The Alexandrian Ring*, Alexander the Great had to fight against his alien equivalent so that a horde of tycoons could have something to bet on. Now, that "game" having ended in economic disaster for the tycoons, the villains must be punished. And how better than by making them the centerpiece of a game of their own? Aldin Larice, game arranger extraordinaire, must confront his patron, Corbin Gablona, and Sigma, another villainous tycoon, in the Hole—a world populated by murderous Shi'ites who think everyone else is fair game. Larice is the honorable hero, and he gets to take with him 44 honorable ronin of ancient Japan. Gablona, brim-full of deceit and skullduggery, takes Hassan's Assassins. Sigma chooses a corps of alien berserkers. And the fight is on.

But honor versus deceit is only half the tale, and not the half that gives this one most of its interest. Bill figured that the betting in such a situation would be interesting, especially if someone could set up a lottery based on outcome. That is, a ticket might specify Larice killed by natives on day 15, Sigma on day 23 by Gablona, Gablona survives. There are millions of such outcomes, and the market for the tickets is all the many billions of citizens of the two Magellanic Clouds. There is thus the potential for great riches to be made in this game, and thus for even greater skullduggery, and still more economic disaster, not just for the tycoons, but for civilization as a whole.

Sadly, the recitations of probabilities soon grow exceedingly tiresome and the characters are thinner than usual for Bill (the ancient warriors, for instance, are little better than automatic weapons systems). Bill's enough of a friend that he called me for help with the probabilities, and I gave him what I could. I wish I could be more positive about the book.

Frederik Pohl's **The Day the Martians Came** looks like a novel but is really a collection of short stories, many of them fairly witty, unified by a carefully constructed frame. The premise is that a U.S. expedition to Mars, thanks to profiteering in its design, review, construction, and outfitting, meets disaster. Most of the explorers die. One of the survivors, idling away the wait for the return launch window, stumbles on a tunnel complex containing what seems to be the near-extinct remnants of an-

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cient Martians. And when the expedition returns to Earth, it brings the Martians with it.

The oldest of the short stories date to 1967 and 1972. The rest are more recent, and they seem to have been written, along with the framing episodes, with the premise in mind. Most deal with the responses of people back on Earth to the situation. There are the hack screenwriter, the tinpot dictator, the naturalist, the sucker-seeking mystics, the defector from the Soviet space program, the real estate developer, all equally tunnel-visioned. Yet when the Martians arrive on Earth, the tunnel vision disappears. Millions, including many of the characters I just mentioned, throng to Florida, and the planet positively glows with common purpose, brotherhood, togetherness. This is, perhaps, what Pohl thinks is the best thing to emerge from the space program: the rising above pettiness, the sense of us all as one, the pride everyone on Earth felt when the first astronauts orbited, or landed on the Moon, or spacewalked, or returned to Earth.

He may well be right. Certainly, that planet-wide emotional unity is far more to be desired than the fear, hatred, jealousy, envy, and greed that stain our more mundane tempers.

I am pleased to report that the second volume of George Zebrowski's original anthology, **Synergy: New Science Fiction**, strikes me as stronger than the first. James Morrow gives us a very effective *reductio ad absurdum* of multiple personalities in "Diary of a Mad Deity." Howard Waldrop plays with moviemaking in "French Scenes." Novice Daniel Pearlman promises a grand future with the strength of "Taking from the Top," his vision of how octogenarians will one day have to scratch for one more year of medical care. Rudy Rucker and Marc Laidlaw go gonzo surfing with the chaos of "Probability Pipeline." Robert Frazier's long poem, "The Daily Chernobyl," plays "if this goes on . . ." with nuclear pollution. The late James Tiptree, Jr., (Alice Sheldon) contributed "Backward, Turn Backward" for a full third of the book. Sadly, this one is the book's weak point, for its intriguing premise that youth and old age can switch places temporarily, in a form of time travel supposedly limited by the fact that only bodies, no change, no information, can return through time, is followed through so inconsistently that it collapses under the weight of contradictions. In addition, the story also appeared in Tiptree's last collection, *Crown of Stars*, reviewed in the March column; if you bought that one, then *Synergy*'s high price will net you only 150 pages of ordinary-sized paperback.

The book closes with a reprinted essay by Andrew Joron on "State of the Art: SF Poetry: A New Genre." I will note here only that Joron's views of what poetry should be are much more conventional—and surely more informed, for he *is* a genuine poet—than my own.

I don't cover much horror fiction here, or much fantasy, but I just have to put in a plug for **Haunted New England**, edited by Charles G. Waugh, Martin H. Greenberg, and Frank D. McSherry, Jr. Why? Quite simply, it came my way because I have a story in it ("Roll Them Bones," the eleventh of my "Howie and the Mayor" stories to see print). You may want it for the company I'm keeping there—it includes stories by Conrad Aiken ("Mr. Arcularis"), Sarah Orne Jewett ("Lady Ferry"), Jack Finney ("Where the

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Cluetts Are''), Oliver La Farge (''Haunted Ground''), Edith Wharton (''The Triumph of Night''), H.P. Lovecraft (''The Shunned House''), Elizabeth A. Lynn (''The Island''), and nine more.

Call it hauntingly varied.

Give Hans Moravec a chance, and he will tell you that within fifty years we will have computers as capable of intelligence as a human brain. A few years after that, and humans will be hopelessly outclassed. They may have the option to be translated into silicon minds, but why bother? The machines will be our children in all but blood, and we will watch wistfully as those children claim the galaxy, the universe, and perhaps, if Moravec's intuition is sound, eternity. Meat humans will then wither away; the species will decline into extinction. But our descendants will go on.

Moravec, says Harvard University Press' puff sheet, ''is a brilliant and wildly imaginative scientist, and his enthusiasm for his subject is unparalleled and highly contagious.'' The quotes from famous writers call him ''a visionary'' and ''one of the most original thinkers in the field of artificial intelligence,'' and say he presents ''new and mind-boggling possibilities with an insistent and somewhat bone-chilling logic.''

The book, **Mind Children: The Future of Robot and Human Intelligence**, takes its readers from the basics of artificial intelligence and the history of computers to the most far-flung reaches of space and time. And it is indeed mind-boggling and bone-chilling, at least to any reader who has not spent a little time in the SF armchair. SF fans are likely to find Moravec's offering intriguing but not startling; they've seen it all before, with the possible exception of Moravec's conclusion that humanity should take its inevitable withering away with good grace.

How convincing is Moravec? He bases his arguments on simple trend projections fortified with almost as much arm-waving as one finds in fiction. But what else could he do? He's speculating, he does it well, and his audience is those academics and lay persons who wouldn't be caught dead reading sci-fi junk.

Do you know anyone like that? Then consider giving them a copy of the book. It will stretch their minds as effectively as a novel by, say, Bear, Benford, or . . .

Dorothy Nelkin's **Selling Science: How the Press Covers Science and Technology**, published in 1987, is now out in paperback, and I recommend it. It is a thoughtful consideration of the attitudes of journalists toward scientists and science, of scientists toward journalists and journalism, of the differences in the ways scientists and journalists approach knowledge, of the marketing of science and news, and of how these differences affect the news we see in the daily paper and on TV. Read it, and you will have a much better idea of why scientists say, ''Hmmm . . . maybe . . . if this checks out . . . then we'll have one more little detail nailed down,'' and journalists say, with a blast of trumpets, ''BREAKTHROUGH!! TOMORROW!! DISASTER JUST AROUND THE CORNER!! A CURE ON THE WAY TO A DRUGSTORE NEAR YOU NOW!!''

Unfortunately, Nelkin misses two bets. She alludes to the way the American public views scientists in something of the same way it views athletes, but she neither develops the comparison nor suggests that both science journal-

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ism and society's attitude toward science might benefit from strengthening the similarity. Think about it: There is a fundamental likeness of the two realms, for sports embodies one of our society's grand ideals, that of fair play. Science embodies another, that of objectivity. Athletes and scientists thus take on something of the shine of idols, and the journalists who cover their deeds become worshipers. Because the ideal of science seems less accessible to most, science writers worship less critically, and science news shows it, both in the way it presents new developments and in the way it reacts to failures of objectivity. If we could but teach objectivity as we do fair play, in the schools, then scientists might seem less distant, and then the way would be open to making science more of a spectator sport. The concept of corporate and university "science teams," with frank recognition of the competition that already exists, might make science seem more exciting and hence more deserving of public support.

The other bet that Nelkin misses appears when she comments that, because science writers are so worshipful, there is a severe lack of analytical reporting, such as we see so much of in politics, economics, education, and even sports. There are, she says, no science analysts writing for the general public. And I think she's wrong: there are some very perceptive, insightful analysts of science around. The trouble is, they tend to do their work at book length. And many of them present their analyses as the morality plays we call science fiction.

ANADEMS

Between 1978 and 1981, Stephen King published in *F&SF* a number of rather cryptic tales of a distant, dusty, fin-de-siècle future. The time was long after our civilization had vanished into dust and relics. The protagonist was Roland, a young man fleeing the fall of his ancestral home to revolution, carrying his holy six-guns, pursuing some ineffable villain. The Gunslinger, hot on the trail of the Man in Black, his eyes intent on a Black Tower at the nexus of all space and time. The impetus, as King writes, was "a sense that it was time to stop goofing around with a pick and shovel and get behind the controls of one big great God a'mighty steam shovel, a sense that it was time to try and dig something big out of the sand, even if the effort turned out to be an abysmal failure." The result was the five segments of **The Gunslinger**, illustrated in color by Michael Whelan and published in 1982 by the specialty house of Donald M. Grant and now, in a 224-page trade paperback, by Plume (Signet), for $10.95.

Is it the failure King feared? Well . . . King grants that it *is* pretty blatantly modeled on the coming of Childe Roland to the Black Tower. It is also too heavily and obviously freighted with symbolism, and too self-conscious a shot at "literature," to be a complete success. But it's quite readable, even on second exposure. And there will be more; the next planned volume is *The Calling of the Three*.

When you pick up James White's **Federation World** (Ballantine/Del Rey, $3.50, 284 pp.), it may seem familiar. That's because it is a collection of stories set in a frame, and at least one of the stories appeared in *Analog* some years back. You may recall it: First Contact specialists from the Federation arrive on the world of Teldi, whose natives long ago accidentally blew up their moon, and used their nuclear arsenals

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to pulverize the largest and most threatening chunks. Now they suffer a constant rain of rubble and, since that long-ago accident happened because a technician failed to check a detail for himself, they have made a fetish of responsibility. Fine *Analog*ical problem-solving.

The novel is something else, for the frame dominates the whole, as perhaps it should. The Federation is a group of sentients who have charge of a Dyson sphere near the galactic center. His task is to find all sentients in the galaxy, separate out their sheep and shepherds and transfer them as Citizens to the Federation world, where in due time they will meet, interact, and engender wonders. Each species, of course, also has its wolves, or Undesirables, who are left at home to devour each other, and a very few who are driven by curiosity and become Federation staffers. The book follows a pair of the latter through several of their adventures. In the process, it beautifully displays White's gift for imagining aliens and delivers an admirable sermon on the virtues and potential benefits of altruism and cooperation. ■

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brass tacks

Dear Stan:

I found your editorial on the Fermi Paradox (in the November ish) unconvincing. It's true that most tools in modern culture are context-dependent, and would make no sense to a primitive. Nonetheless, it would be clear to the primitive they are *artifacts*, not merely weird natural products. (In one of his essays Hofstadter talked about "levels" of messages; that although (for example) one may not have, or understand, the decoding necessary to read a floppy disk, the fact that it *is* a disk communicates that it is an artifact.) That seems to me to be the key. Even if supercivilizations were communicating, or carrying out other activities in ways we can't understand, it seems that *something* nonnatural should be apparent. But, as Freeman Dyson has long pointed out, the Universe seems woefully unorganized for intelligence to be common. We may not understand what was going on; but that there's *something* going on should be painfully obvious. (E.g., consider contrails over a Primitive Area!)

For similar reasons I find Martyn Fogg's explanation of the Fermi Paradox unconvincing. If civilizations are pervasive, it seems more effects should be prominent. We wouldn't understand them, but it would be obvious *something* requires explanation. It's analogous to Lovelock's Gaia hypothesis: Life remakes its environment, to create a steady-state system far out of chemical equilibrium. It's obvious from *very* far away the Earth is a living planet. But the Galaxy just seems too explainable by ordinary physical processes (as Lovelock remarked about Mars—to the annoyance of the Viking researchers!) for spacefaring life to be common.

STEVE GILLETT

Dear Dr. Schmidt,

I've recently had the pleasure of rediscovering *Analog Science Fiction/Fact* magazine. I had thoroughly enjoyed many fine stories and articles some twenty years ago, in my adolescence. Picking up a recent copy I discovered that the excellence continues and I rediscovered the importance of taking time to explore new ideas thru science fiction; to imagine, reason and wonder.

I found Martyn Fogg's article, "Extraterrestrial Intelligence and the Interdict Hypothesis," in the November issue to be thoroughly engrossing and thought provoking. And in many ways it is entirely convincing. But it seems to me that some additional extrapolation is necessary; to reexamine the basic assumptions.

It seems unlikely that a civilization that is capable of interstellar travel would in any way be "steady-state" for billions of years. If natural selection were still operating on that species, it would be significantly transformed every million years or so. But it seems far more likely to me that a species that

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advanced would be designing itself, accelerating the change process dramatically.

We can already see the possibilities at our own technological level. We are starting to unravel the structure and meaning of the genetic code and are finding ways to manipulate it. It seems likely that, in the next few hundred years or so, for better or worse, we'll start trying to make "better" humans. (This will be opposed by almost everyone but eventually, I would guess, it will be done.) And we'll probably eventually succeed at cranking out a few (or maybe many, possibly thru cloning) geniuses. With their help, the next generation should be of even higher intelligence (and hopefully very wise, compassionate, and other good stuff). This could start off a chain reaction, starting an evolutionary explosion, and compressing millions of years of evolution into hundreds.

It's extremely difficult to imagine what the civilization of a self-modifying species would be like and what its goals would be. Both the species and the civilization would be extremely advanced and would change very rapidly. And with every advance it could progress faster, until it became some unimaginably advanced life form (or many types of life forms). It's even hard to imagine what the species' "final" or "steady-state" physical form would be.

It seems unlikely that such a civilization would be searching the galaxy for raw materials with which to produce goods. The technology should be much more sophisticated than that. And it may be unlikely that the species would be searching the galaxy for new planets on which to make babies. While this is a natural inclination (i.e., it has survival value and therefore has survived) the self-modifying species would be freed from the constraints of natural evolution and might choose to reduce or eliminate this inclination. The species might also be immortal and choose to no longer reproduce under normal conditions.

Of course, the self-modifying technology is extremely dangerous. It could easily produce unbalanced and dangerous superpersons. It is one more way in which an intelligent species could wipe itself out.

WAYNE SCHROEDER

San Diego, CA

Dear Dr. Schmidt:

The recent *Analog* article entitled "Extraterrestrial Intelligence and the *Interdict Hypothesis*" by Martyn J. Fogg was a very interesting and useful contribution. I have, however, never seen mentioned the primary reason that I believe we have not been contacted, namely, that we do not qualify as an "intelligent species." On the face of it, this seems ridiculous. After all, we are tool users, with a very high degree of sophistication, and exhibit numerous signs of intelligence. However, I would like to discuss this, not from a human point of view, whence we obviously qualify, but from an extraterrestrial intelligence's point of view.

First, let us consider the article's time scale. Martyn Fogg starts his simulations at 5 billion years BP (before present), and concludes that in a time period of less than approximately 50 to 100 million years, the galaxy becomes "saturated." In other words, the galaxy is saturated with intelligent life some 4.9 billion years BP. Even if the figures were out by a factor of ten, this would still leave the "Colonization Era" over some 4 billion years BP. This gives these extraterrestrials (a somewhat geocentric term!) about 4 billion years of evolution before we show up. I don't

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think I have to spell out what four billion years of evolution can do; *Homo sapiens'* evolution from Neanderthal man took considerably less time than this, by several orders of magnitude, let alone man's evolution from lower life forms.

Of course, this leads to the argument that further evolution beyond our current state is not likely or feasible. I think the literature bears out the hypothesis that we are currently evolving; there appears to be (admittedly minor) changes between our ancestors from the 1600s and ourselves. If minor changes can happen in that time, I cannot but believe that more major changes could occur in, say, one hundred times longer, or 40,000 years. This is still a small fraction of the time span available.

However, perhaps Dr. (Mr.?) Fogg's simulations are completely incorrect. Even so, events in the galaxy happen on a galactic timescale. In other words, a short time in galactic terms is at least of the order of millions of years, if not hundreds of millions. Given that we are approximately two thirds of the way from the center of the galaxy to its edge, and that stars closer to the center of the galaxy develop earlier, and the simple number of these stars, even an almost vanishingly low probability of stars having planets on which intelligent life develops would lead to several such civilizations with at least a billion years' development and evolution before *Homo sapiens* evolves. This line of thought has lead me to consider just what such a civilization might do. We can analogize by considering ourselves encountering a civilization of, say, Neanderthal man. Given what we know today about contamination of cultures, I think that there is a reasonable likelihood that we would leave them alone, at least in the sense of contacting them. We would very likely try to monitor them in some way, perhaps electronically, so that we would know if they became more capable. Our history suggests that in the case of extraterrestrials monitoring us, a reasonable test for technology might be the development of radio—this also has the benefit that it is easily monitored. A second test might be the development of space travel on a basis which enables the species to visit the nearby planets (this might be accomplished by putting an intriguing object on a nearby planet, such as a face—nothing too obvious, but something which the species in question would be likely to visit, thereby triggering an alarm). I must confess I am thinking in *Homo sapiens* terms here — I'm sure the technology of an extraterrestrial civilization would be much further advanced.

I would like to make a comment on SETI. SETI is, I understand, primarily using electromagnetic waves in its search. While one can argue that there are universal constants in the spectrum, such as the absorption characteristics of hydrogen, given our discussion of timescales above, it seems to me that this may well be one of those things that civilizations discover early on. Perhaps "the electromagnetic era" of civilizations is typically short (say, 500 years), and after that some new features of the Universe are discovered which are much more fundamental, or, perhaps, allow much faster communication. Of course, civilizations could periodically (say, every thousand years) scan the galaxy to see if a new radio source had developed, but only if they wanted to find civilizations which were at that particular stage of development. In any event, I can't see it being likely that, given the galactic timescale, that any other civilizations would be at the same stage of development, within 500 years, in such

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a way that we could pick up their electromagnetic signals and recognize them as such. A quick calculation, assigning reasonable probabilities, will show that the word "unlikely" is a massive understatement! Of course, the recognition issue was addressed in your editorial.

I would like to end by saying how much I enjoy *Analog*. The combination of thought-provoking fact articles which discuss real science (rather than popularized science) with enjoyable and (usually) thought-provoking science fiction articles makes for a magazine which I read cover to cover every issue!

TIM BOREHAM

Ontario, Canada

Dear Stan,

Martyn J. Fogg's article, "Extraterrestrial Intelligence and the Interdict Hypothesis," certainly represents an enormous amount of skillful work by an unusually imaginative mind, but leaves this reader, at least, unconvinced. Perhaps that's because I have just been dabbling again in Sir Francis Bacon's writings on the "Idols of the Tribe" in which he reminds us of several counterproductive intellectual tendencies. One of these is to suppose more order and regularity in the Universe than is really there. Another is the tendency to select those observations that support our preconceptions.

Mr. Fogg, in predicting the growth and colonization of extraterrestrial cultures, too readily supposes that randomness is always somewhat regular if you have a large enough sample. It often is, which is the basis, for example, of psychometrics. However, randomness can also be truly random, as Sir Francis reminds us. It is therefore unwise, lacking any real data whatsoever, to base a whole theory on the predictability of randomness.

Furthermore, much of Mr. Fogg's argument on why we have not received signals from his supposed billions of ET cultures rests largely on the hypothesis that they intentionally preclude our receiving their signals by using "tight beams, such as lasers." Well, he could be right there—but for the wrong reasons.

If the ETs are using lasers to communicate among themselves, the most important reason we are not intercepting their messages may be that humans are not searching for ET messages in the laser frequencies. However, it is impossible to believe that avoiding Earth reception would take priority over the enormous practical advantages of broad beam or broadcast communications among the galactic clades he imagines.

I'm sure it's no coincidence that you chose to print in the same issue Robin F. Rowland's delightful "Wait Until Next Year," in which the decoding of the ET sportscast signals is mostly pure luck. As I've said in two *Analog* stories, and as you say in your November 1988 editorial, we might not recognize an ET's signal as such even when we see it—simply because we are looking for what we of Sir Francis's "tribe" would send!

FRANCIS CARTIER

On the other hand, considering the size of the targets, a galactic clade might prefer narrow beams simply because broadcast is very inefficient from purely energetic considerations. The author adds this . . .

Dear Stan,

Thank you for letting me look at Francis Cartier's correspondence concerning my article "The Interdict Hypothesis."

It is essentially *equilibrium* that I am proposing, rather than order or regularity. What my simulation shows is that, should both the origin of life and inter-

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stellar colonization not be too improbable, then the Galaxy would be rapidly settled by not one, but *several hundred* advanced progenitor civilizations (clades). In other words the Galaxy undergoes a cusp catastrophe from one equilibrium state (lack of intelligent life) to another (saturation). What my *Icarus* paper considers is how such civilizations might react to a future of billions of years of inescapable co-existence and limits to growth. It seems to me that there would be two possible outcomes per individual civilization—rapid self-destruction, or strict "steady state." These are themselves equilibrium states. It is through this that one might conceive of the Earth having been set aside by extraterrestrials, especially as the colonization era of the Galaxy could have ended millions of years before the Solar System formed. Thus, order and regularity are second order effects of equilibrium, so in my view this criticism of Cartier's is not a serious one.

I agree with Cartier's comments concerning ET broadcast strategies. It is quite possible that we might not recognize signals between civilizations millions of years more advanced than ourselves. An analogy has been made that we might be like the tribespeople in the depths of the Borneo jungle who communicate with drums, being totally unaware of the passing radio waves of 20th century civilization.

MARTYN J. FOGG

Dear Stan:

While I'm delighted that John Thiel enjoyed "Water Rite" so much, Jim Rawley's letter in the same Brass Tacks column (November) bothers me somewhat.

Rawley feels that the story was not "science fictional" enough. But if one compares the information given in the story with the real world of today, one must conclude that tapping the aquifer that lies three kilometers below the surface of the Sahara is beyond present technological practice. So the technological idea at the core of the story is clearly science fiction.

I do not explain how computers work, nor did I think I had to. The day of detailed explanations of hardware (or software) is long past; the average SF reader is willing to grant that computers can be programmed as suggested in the story, I believe.

Also, the sociological ideas of an International Peacekeeping Force and Cole Alexander's band of ecologically-minded mercenary soldiers seem to me to be valid areas for science fiction to explore.

For many years now I have been writing novels of the very near future, novels that examine how new technologies can alter our political and social world, and change the lives of individual human beings. To me, that is the most exciting area of science fiction—the area that examines *how* we can build the future that we all want to see. There are plenty of writers who cast their stories in the far-flung future. I'm more interested in reality, and in how we get to where we want to be from where we are today.

"Water Rite" has been incorporated into my novel *Peacekeepers*, for any readers who want to learn more about that world that is just around the corner.

BEN BOVA

Dear Sir;

I would like to comment on G. Harry Stine's State of the Art in the November issue. The article seems worthy of comment to me because the general attitude in science fiction circles seem to be " 'Star Trek' isn't science fiction—it's space opera or fantasy." I have seen

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many disparaging references. Certainly some (much? most?) of the science in "Star Trek" would be very hard to defend. The stories did not generally involve the most inventive plots from a science fiction point of view. "Star Trek" had something science fiction in print did not have—enormous public exposure. Even though a failure in the ratings game it reached an enormous audience. Somehow this seemed to cause resentment to some: why should "Star Trek" become a phenomenon when better science fiction did not?

As I liked "Star Trek" and "regular science fiction" I never quite grasped why the two seemed opposed in some way (I know "Star Trek" won a Hugo, but I believe "Star Trek" had a second class status to the general science fiction reader). Although I would say that appreciating "Star Trek" would not expand the horizon of a science fiction reader, I believe the reverse is true. We all know how much science fiction has expanded to reach a wider audience in print and movies/video; how much of this can be attributed to "Star Trek" is debatable, but certainly some.

Reading Mr. Stine's article was therefore quite interesting. I was pleased to see the good opinion he expressed and hope it is symptomatic of the general belief of *Analog* readers. Although *Analog* has a certain style and a specialized readership, it is sometimes important to be reminded that *Analog* does not exist in isolation; it is part of a wider science fiction world which includes "Star Trek," and an occasional reference to "non-*Analog*" type facets of that world is welcome.

Let me also take this opportunity to praise The Alternate View department. I find it usually quite interesting and informative, and look forward to reading it in each issue. It is the blend of fiction, editorials, science, and the other readers departments—as a whole—that sustain my interest in *Analog*.

TERRY M HULETT

Newport News, VA

Dear Dr. Schmidt:

Although a near lifetime reader and subscriber to *Analog/Astounding*, I have never taken the time to write a letter, although frequently moved to do so (you began publication in 1930; I began life in 1936 and began reading *Astounding* in 1948). Over the past forty years, I have found a "friend" in my *Astounding/Analog* magazines.

I am writing now because I have learned of a potential tribute to be paid to Robert A. Heinlein, whom all *Analog/Astounding* readers know and love. I have not seen the tribute mentioned in recent issues of *Analog*; therefore, I would ask you to advise all of the faithful so that they might make their wishes known to the appropriate authorities.

I understand that the National Space Society (NSS) has begun a campaign to urge NASA to name its forthcoming space station after Heinlein. *Analog* readers wishing to support this proposal should write to the NASA Administrator, James Fletcher, and send it to:

Heinlein Space Station
%NSS
922 Pennsylvania Avenue, S.E.
Washington D.C. 20003

Any of us who have read *The Moon is a Harsh Mistress* would have to support this appropriate tribute to a great man whose visions of the conquest of space and time have captured our imagination and challenged our inventiveness. I hope that *Analog* readers will respond with a flurry of letters to NASA supporting this tribute to Robert A. Heinlein.

JAMES E. BURDETTE

Kettering, OH ■

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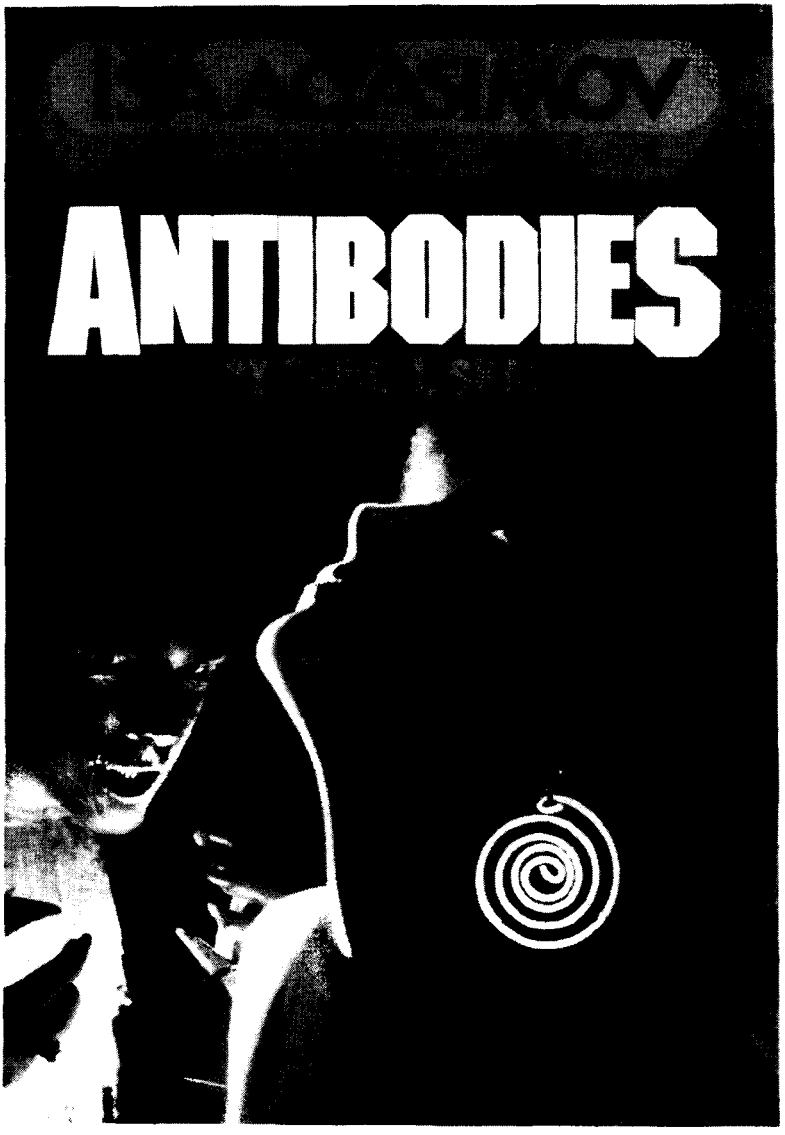

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